Intergovernmental Data Quality Task Force

Quality Assurance/Quality Control Compendium: Minimum QA/QC Activities (Appendix to the Uniform Federal Policy for Quality Assurance Project Plans)

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EXECUTIVE SUMMARY

Introduction

This ***Quality Assurance/Quality Control Compendium*** (QA/QC Compendium) has been prepared by the Intergovernmental Data Quality Task Force (IDQTF) to supplement the ***Uniform Federal Policy for Quality Assurance Project Plans*** (the UFP-QAPP) currently under review. The UFP-QAPP and the QA/QC Compendium serve as companion documents to the IDQTF's ***Uniform Federal Policy for Implementing Environmental Quality Systems*** (UFP). The UFP, the UFP-QAPP and the QA/QC Compendium were developed as consensus initiatives by the U.S. Environmental Protection Agency (EPA), the Department of Defense (DoD), and the Department of Energy (DOE).

The purpose of the UFP-QAPP is to serve as a single national consensus document for consistent and systematic implementation of project specific guidelines per ANSI/ASQC E4 (***Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs, Part B).*** The purpose of this QA/QC Compendium is to establish minimum specifications for data quality activities for all phases and data uses in the CERCLA process. It is intended to be included as an appendix to the UFP-QAPP.

Background

Applicability Beyond Hazardous Waste

The QA/QC Compendium was developed to address quality assurance for hazardous waste cleanups but the document may be used as a model for other programs.

There are inconsistencies in QA/QC activities implemented as part of the CERCLA process across EPA, DoD, and DOE. An IDQTF workgroup collected information on the written policies of EPA Regions and DoD facilities regarding QA/QC activities for CERCLA projects. The findings from that survey showed that less than 1 percent of the possible QA/QC activities were required in written policy by more than 75 percent of the participants. The lack of a consistent approach leads to costly negotiations between the Federal agencies and regulatory agencies to establish operable unit, site and/or facility-specific specifications on a case-by-case basis. Such negotiated quality guidelines may be inconsistent with quality specifications negotiated for similar CERCLA projects at other operable units, sites, or facilities within the same or different states, EPA regions, or Federal facility field offices.

The IDQTF workgroup spent almost 2 years collecting and reviewing information and developing a consensus on data quality specifications for each CERCLA phase (e.g., RI, FS), data use (e.g., human health risk assessment), project stage (e.g., planning), and data type (screening versus definitive data). The workgroup assessed the current state of required QA/QC activities and developed a value-added set of minimum QA/QC activities appropriate for all CERCLA phases. This QA/QC Compendium presents the consensus workgroup product, including a table that illustrates the consensus minimum QA/QC activities for each project stage, data use, and data type of the individual CERCLA phases (a QA matrix).

Highlights of the QA/QC Compendium

The QA/QC activities identified in this document cannot be easily summarized in an executive summary. However, the following outline of the principles that form the basis of the guidelines may help the user place the more detailed specifications in context:

- Workgroup development of the QA matrix revealed that the differences between minimum QA/QC activities that support screening data versus definitive data are more significant than any differences between CERCLA phases or data uses.
- The specifications in the QA matrix do not substitute for the Systematic Planning Process (SPP) prescribed by E4, the Interim Final UFP, and the UFP-QAPP. The implementation of a team-based SPP is one of the QA/QC activities in the project planning stage.
- QA/QC activities specified in the QA matrix represent a consensus *minimum* list of activities. QA/QC activities may be added, depending on project objectives and on site-specific conditions.
- The workgroup performed an analysis of value-added QC samples that provide information on data quality indicators (e.g., precision, accuracy, sensitivity). As a result of this analysis, a reduction was made in the minimum QC samples specified for CERCLA projects based on each sample's respective added value to the understanding of the quality of data.
- The data review project stage includes three types of data review processes: sampling and analysis verification; sampling and analysis validation; and data usability assessment. These three processes encompass sampling data quality (e.g., results from sample collection activities) as well as analytical data quality. In addition, the definitions and examples of activities for these three steps go beyond what is currently considered to be data review.
- Certain issues related to data review are addressed in a revised Chapter 5 of the UFP-QAPP. These include data review inputs, example data review activities, opportunities for streamlining, and documentation of data review activities in the project-specific QAPP.

Organization of This Document

This document is organized into three sections and two appendices:

- Section 1: Introduction, including scope and background, as well as overview of key decisions.
- Section 2: Foundations of the QA matrix, summarizing IDQTF policy decisions regarding key definitions and the minimum activities of the QA matrix itself.
- Section 3: Introduction to the QA matrix, including appropriate matrix use in the development of project-specific QAPPs.
- Appendices: Appendix A provides an evaluation of QC samples and their contribution to understanding specific data quality indicators. Appendix B provides a comprehensive list of acronyms and definitions.

The QA/QC Compendium has been created as a stand-alone document to help the reviewer understand its development and the decisions it embodies. The specific QA/QC activities, and a brief introduction to them, will eventually be included in a third appendix to the final UFP-QAPP.

Quality Assurance/Quality Control Compendium: Minimum QA/QC Activities

1.0 INTRODUCTION

This document is a product of the Intergovernmental Data Quality Task Force (IDQTF), which comprises three Federal agencies: the Environmental Protection Agency (EPA), Department of Energy (DOE), and Department of Defense (DoD). The mission of the IDQTF is to develop a quality assurance system for environmental data collection.

The goals of the IDQTF include the following:

- Develop a written agreement that constitutes an adequate quality assurance (QA)/quality control (QC) program.
- Develop a guidance/framework that outlines the roles and responsibilities of the EPA (Headquarters and Regions) and other Federal agencies with regard to QA/QC oversight.
- Develop guidance for implementation of Federal agency-wide specifications and procedures regarding data quality.

The IDQTF is in the process of developing several work products to promote the goals of the task force. This compendium is one of several IDQTF products that are specifically designed to provide Federal consensus policies for the implementation of the national quality standard developed by ANSI/ASQC and known as E4 – ***Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs*** (American National Standards Institute and American Society for Quality Control, 1994).

Current Products of the IDQTF

Uniform Federal Policy for Implementing Environmental Quality Systems (Interim Final, November 2000, also called UFP) – A high-level policy based on E4, Part A, "Management Systems."

Uniform Federal Policy for Quality Assurance Project Plans (Review Draft, Version 2, June 2001, also called UFP-QAPP) – Designed to implement Part B of E4, "Collection and Evaluation of Environmental Data."

QA/QC Compendium (Review Draft, May 2002) – Designed to supplement the UFP-QAPP with minimum QA/QC activities for investigations and cleanups under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and similar programs.

1.1 Purpose

The purpose of this **Quality Assurance/Quality Control Compendium: Minimum QA/QC Activities (QA/QC Compendium)** is to outline the minimum QA/QC activities that should be included in a Quality Assurance Project Plan (QAPP) for sites undergoing investigation and cleanup under CERCLA. These activities are listed in a QA matrix located in Section 3 of this document. The QA matrix is designed to address the problem of inconsistency of QA/QC activities for CERCLA projects. The goal is to ensure appropriate data quality at CERCLA sites by instituting a set of uniform QA/QC activities common to all CERCLA data collection and use activities.

Applicability Beyond Hazardous Waste

The QA/QC Compendium was developed to address quality assurance for hazardous waste cleanups but the document may be used as a model for other programs.

The current practice has been characterized by activities that vary among EPA Regions, facility types, and sites. It is costly in terms of time and expense to negotiate and implement different specifications for individual projects, and cumbersome for a manager who has no guidelines to follow. Use of the minimum activities found in this QA/QC Compendium will save time and money, as well as reduce redundant activities and/or activities that add little value to the understanding of the quality of the data. It is anticipated that the members of the IDQTF (DoD, DOE, and EPA) will adopt the specifications advocated in this document.

This document addresses several goals for the management of environmental data collection and use, including:

- Improve the quality of environmental data collection, analysis, and use by ensuring that an appropriate minimum level of QA/QC takes place for every CERCLA phase, data type, and use.
- Reduce costs by:
  - Minimizing project-specific conflicts on QA/QC activities, or
  - Eliminating those QA/QC samples that are redundant or provide limited value to understanding the true quality of data.
- Establish a common understanding of required QA/QC activities across all Federal agencies. This includes all branches of DoD, all EPA Regions, and all DOE facilities.

This QA/QC Compendium will form the basis for an appendix to the UFP-QAPP guidance. This document contains:

- Background on the major decisions made by the IDQTF in developing minimum QA/QC activities.
- Definitions of QA/QC activities.
- A list of specific QA/QC activities, organized in a simple matrix format (called a **QA matrix**), that can be applied to CERCLA data collection, analysis, and use.

The users of this QA/QC Compendium should include those persons charged with the task of generating a QAPP. The QA matrix may be used by contractors, project managers, and others

dealing with Federal facilities engaged in the CERCLA process. It is designed as an outline of QA/QC activities that should be performed and documents that should be generated during and preceding CERCLA actions. These guidelines may be appropriate for non-CERCLA decisions that are similar in nature, such as the corrective action program of the Resource Conservation and Recovery Act (RCRA). The matrix is comprehensive in that it addresses the CERCLA process from the planning stage to the site closeout stage. The activities are labeled as minimum because it is the intent of the IDQTF that all activities specified in the QA matrix be included in the project-specific QAPP. Additionally, project-specific QA/QC activities may be added by the project team.

1.2 Scope of the QA/QC Compendium

The scope of the QA/QC activities in this document includes the sample collection, sample analysis, and data use components of the CERCLA process at Federal facilities. These specifications apply to the collection and use of data for:

- All phases of the CERCLA process (e.g., site investigation, remedial investigation).
- The purpose of making specific decisions using primary (original) data collected during CERCLA phases.
- Both screening data, for intermediate decisions, and definitive data, for final decisions.
- All stages of project management, from planning, to data collection and analysis, to data review.

Secondary data (i.e., data generated for another purpose than the project for which it is used) is not addressed in this document. In addition, QA/QC activities specific to radiochemical data collection, analysis, and use are not included in the matrix. Radiation QA/QC guidance can be found in the *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) which provides a nationally consistent consensus approach to conducting radiation surveys and investigations, and the *Draft Multi-Agency Radiological Laboratory Analytical Protocols* (MARLAP) manual which addresses the need for a nationally consistent approach to producing radioanalytical laboratory data that meet a project's or program's data requirements.

Specific attention was paid to the value of different types of QC samples and their role in understanding three data quality indicators (DQIs): precision, accuracy, and sensitivity. Therefore, the final QA matrix listed certain QC samples as minimum activities, but omitted others that may be commonly used because they were considered to be of limited value or duplicative of other QC samples. Some of those omitted from the QA matrix may be reinstated by project teams making site-specific decisions.

Use of Minimum Activities in QA Matrix

Activities in the QA matrix should occur as specified. Activities not specified in the matrix, but necessary to the project, may be added.

After careful analysis of each CERCLA phase-data use combination, it became apparent that the greatest commonality of minimum QA/QC activities was with regard to data type. The matrix therefore divides the QA/QC activities into two types of data – screening data and definitive data.

- **Screening data** can support an intermediate or preliminary decision but should eventually be supported by definitive data before a project is complete.

- **Definitive data** should be suitable for final decision-making (of the appropriate level of precision and accuracy, as well as legally defensible).

1.3 Background

1.3.1 QA Matrix Workgroup

In 1999, the IDQTF initiated a QA Matrix Workgroup to gather information on Federal agencies' understanding of current QA/QC activities under CERCLA. The QA Matrix Workgroup was chaired by Robert Runyon, QA Manager from EPA Region 2, and included chemists, other QA personnel, and remedial project managers (RPMs) from the three IDQTF agencies (EPA, DoD, and DOE). The goal of this information collection effort was to determine the level of agreement in written policy among EPA Regions, DoD components, and DOE and to use that as a point of departure for recommending minimum QA/QC activities for all Federal agencies.

During the course of workgroup discussions, a variety of specific issues were examined in depth, including:

- The minimum QA/QC activities to support DQIs (precision, accuracy, and sensitivity) for each project stage.
- Clarity of definitions for QA/QC activities and data types.
- The nomenclature and organization of post-ROD and post-construction project stages.
- The role of CERCLA phases versus data uses as the common denominator of QA/QC activities.
- Definitions of data review activities, and the differences between the current scope of such activities and the desired future scope.

1.3.2 Findings from the QA Matrix Information Collection Process

The information collection and analysis process showed that the most significant common ground among EPA Regions and between EPA and other Federal agencies was the lack of agreement on minimum activities for QA/QC.

Findings on Current QA/QC Activities

- There is little current consensus on QA/QC activities for most CERCLA phases and data uses.
- The broadest agreement for QA/QC activities is for definitive data used during a remedial investigation.
- Discrepancies exist between EPA Regions and other Federal agencies on definitions of key terms relating to environmental data QA/QC.

For each project stage under a given data use, a list of potential QA/QC activities was provided from which those submitting the information on QA/QC policies could pick (the pick list). Although there are 10,530 possible combinations of QA/QC activity, data use, and project stage, the consolidated QA matrix (i.e., combining all information received from the three agencies) revealed that only 37 individual activity-data use-project stage combinations fit in the "most agree" category (i.e., 75% or more of respondents agreed). All 37 combinations were part of the remedial investigation (RI) phase using definitive data. The areas of agreement covered all four primary uses of definitive data in the RI phase: nature of contamination, extent of contamination, human health, and ecological risk assessment.

Understanding the Terms Used in the QA Matrix

The QA matrix data collection instrument was organized around four key terms. Understanding these terms is important to understanding the information presented in this document.

- **Project stage** – refers to the stage of the project preparation, execution, or assessment. Five basic project stages are used in the matrix: planning, field sampling, on-site field measurement, off-site/fixed lab measurement, and data review. (Note: Not all stages are used in every project.)
- **CERCLA phase** – refers to the regulation-mandated project phases prior to, during, and following remediation of a site as defined in the National Contingency Plan (NCP). Phases include but are not limited to preliminary assessment (PA), site investigation (SI), remedial investigation (RI), feasibility study (FS), and removal.
- **Data use** – refers to the purpose of the data collected and analyzed under a given CERCLA phase. Examples include nature of contamination, human health risk assessment, process control, and compliance determination.
- **Data type** – (i.e., screening data and definitive data) refers to the general level of data quality, based on the ultimate use of the data. Screening data can be used for intermediate decisions, whereas final decisions require the use of definitive data.

1.4 QA/QC Compendium - Key Decisions

The information collection process was a point of departure for the workgroup to consider the desired QA/QC activities in the future. This QA/QC Compendium, which is based on the QA Matrix Workgroup's information collection and analysis process, reflects the following key decisions:

- The organization of the QA matrix is based on a combination of CERCLA phases and functions.
- A team-based site-specific systematic planning process is specified in the project planning stage.
- Minimum specifications for QA/QC activities are typically consistent within a specific CERCLA phase, but vary depending upon whether the data to be used are definitive data or screening data.
- QC samples are selected as minimum activities based on the information they provide on specific data quality indicators.
- Data review encompasses both sampling and analytical activities, beginning with a completeness check, through to a data usability assessment based on the decision to be made.

1.4.1 Relationship of Minimum QA/QC Activities to the Systematic Planning Process and Site-Specific Project Quality Objectives

In accordance with ANSI/ASCQ E4 and the UFP, all environmental data collection and use are to take place in accordance with a site-specific systematic planning process (SPP). Using this scientifically based, logical approach to planning for data collection and use at a site helps to ensure that the amounts and types of data collected are appropriate to the decisions to be made at the site, as well as to the special physical, environmental, and chemical characteristics of the site. The minimum specifications documented in the QA matrix do not take the place of this site-specific SPP. In fact, the development of a team-based SPP is one of the first QA/QC activities performed in the project planning stage.

Although minimum QA/QC activities are specified for all environmental data collection and use, a wide range of site-specific guidelines for those activities should be determined that relate to the ultimate use of the data. These guidelines include, but are not limited to:

- Types of decisions that will be supported by the data.
- Project quality objectives.
- Acceptance criteria for data quality indicators (also known as Measurement Quality Objectives).
- Sampling plan, including location of environmental and QC samples.
- Types of contaminants that require laboratory analysis (on-site, field, or fixed lab).

QA/QC activities specified in the QA matrix represent a minimum list of activities. Other QA/QC activities may be added, depending on the decisions to be made and on site-specific conditions.

1.4.2 Organization of the QA Matrix

The workgroup's final product is a matrix of minimum QA/QC activities, which are organized as follows:

- By **CERCLA phases** (e.g., RI, FS), for investigation phases that occur prior to a Record of Decision (ROD) and for removal actions
- By **data uses** (e.g., confirmatory sampling), for post-ROD, construction, and post-construction phases
- By **data type** (i.e., screening versus definitive data)
- By **project stage** (e.g., planning, field sampling)

Each QA/QC activity is listed on the vertical axis under the project stage to which it is related (see Figure 1). Check marks across the matrix identify whether the activity applies to the particular CERCLA phase or data use, and the specific data type. Dashes indicate that the specific activity is not a minimum activity for that CERCLA phase or data use.

CERCLA Phase: Data Use →	**Site Investigation**	
Project Stage ↓ Data Type →	**Screening**	**Definitive**
Planning		
Field Sampling		
On-Site Field Measurements		
Off-Site/Fixed Lab Measurements		
Data Review		

Figure 1. Organization of the QA Matrix

1.4.3 Relationship of QC Samples to Data Quality Indicators

Assurance of data quality is done, in part, through the use of quality control samples. There are several types of QC samples, and each type is related to a set of data quality indicators (DQIs), which are derived from the parameters of precision, accuracy, representativeness, comparability, completeness, and sensitivity (known as PARCCS parameters). The utility of a specific QC sample depends on its applicability to field and laboratory scenarios (e.g., analytical method, sample matrix) as well as on what kind of information is derived from the result of the QC sample. Which QC samples (e.g., matrix spike, laboratory control sample) should be specified for definitive and screening data was determined by linking the contribution of each QC sample to the performance of a specific DQI.

Key Definitions: Data Quality Indicators (DQIs) and QC Samples

- ***Data Quality Indicators*** – refers to the elements that are used to characterize the quality of data. These are reflected in quantitative statistics and qualitative descriptors that are used to interpret the degree of acceptability or utility of data to the user. The principal data quality indicators are precision, accuracy, representativeness, comparability, completeness, and sensitivity.
- ***QC Samples*** – refers to the types of control samples (collected at the site or created in the laboratory) that are analyzed with field samples in order to evaluate the quality of the field results. Examples include matrix spikes, field duplicates, surrogate spikes, laboratory control samples, and equipment blanks.

To determine the relationship of QC samples to data quality, the workgroup evaluated the function of each type of QC sample on the basis of the DQI it was designed to support. Certain types of QC samples were chosen to be minimum activities for the QA matrix based on their contribution to the understanding of one or more DQIs. The following criteria were used during this evaluation:

- Provides an overall measurement of a DQI.
- Identifies specific sources of error (e.g., laboratory, field, transport).
- Provides added value to understanding the data produced from the analysis.

QC samples that either provided the most reliable information on overall data quality or identified specific sources of error were selected to be the minimum activities in the QA matrix. QC samples that are typically operational requirements (e.g., calibration and instrument performance checks) and are needed to run the analytical equipment are not generally included in the matrix because they do not need to be specified as a minimum QA/QC activity. QC samples that were identified by the workgroup as redundant or not informative were also removed from consideration (e.g., bottle blank, water source blank, matrix spike for organics). Table 1 in Section 2.3.1 summarizes the manner in which each QC sample was examined against criteria and the category into which each was placed.

1.4.4 Data Review Definitions

Data review activities encompass a wide range of assessment activities for data verification, data validation, and data usability. Data review is defined by the QA Matrix Workgroup as:

The process of examining and/or evaluating data to varying levels of detail and specificity by a variety of personnel who have different responsibilities within the data management process. It includes, but is not limited to, data verification, data validation, and data usability assessment.

The specifications for data review include two major elements:

- Assessment of the **sample design and collection process**, in addition to assessment of laboratory analytical data.
- Expansion of the understanding of the three major elements of the data review process – data verification, data validation, and data usability assessment. This expanded understanding goes beyond assessing the completeness of data and compliance with method, procedural, and contractual requirements; it **includes assessment of performance and review of project-specific criteria** found in the QAPP, and **assessment of the usability** of the data for the site-specific decision for which it was collected.

The data review process is separated into three steps. Each of these three steps has specific activities that should be completed by a data reviewer.

- Data Verification – Review for completeness.
- Data Validation – Review for compliance with methods, procedures, and contracts, as well as for conformity with quality objectives of QAPP.
- Data Usability Assessment – Assess results of previous data review steps to determine usability of data for making required decisions.

1.5 Organization of the QA/QC Compendium

The remainder of this report is organized in two sections. Section 2 describes in more detail the key policy decisions that are the foundation of the QA matrix and the issues that were addressed by the workgroup. Section 3 describes the QA matrix and the minimum QA/QC activities, as well as what they mean and how to use them. Appendix A contains tables and figures illustrating the contribution of QC samples to DQIs. Appendix B contains a comprehensive list of definitions. Some of these definitions are included in the text as well, in order to enhance reader understanding.

2.0 FOUNDATIONS OF THE QA MATRIX

As described in Section 1, the main components of the QA matrix are type of data, CERCLA phase, data use, project stage, and QA/QC activity. Type of data is divided into definitive and screening, depending on the decision to be made using that data. Within those two types of data, the level of quality is organized by CERCLA phase and/or data use. The potential QA/QC activities are sorted by their place in the project process, from planning to the data usability assessment. Selection of QA/QC activities as minimum specifications is based on the value added to data quality.

This section describes in detail each of those components. The discussion of specific QA/QC activities focuses on QC samples and data review. Many of the activities are self-explanatory, so they will not be described in detail.

2.1 Data Type: Definitive versus Screening Data

After careful analysis of each CERCLA phase-data use combination, it became apparent during the development of the matrix that the greatest commonality of minimum QA/QC activities was with regard to data type:

- **Screening data** can support an intermediate or preliminary decision but should eventually be supported by definitive data before a project is complete.
- **Definitive data** should be suitable for final decision-making (of the appropriate level of precision and accuracy, as well as legally defensible).

Either data type can be effective for various decisions. The major differences in QA/QC activities for the consolidated QA matrix are largely between definitive data and screening data, rather than between CERCLA phases or data uses.

Screening data should not be confused with data of poor quality or with field screening technologies. Field analyses may produce either screening or definitive data, depending on the nature of the technology. Although definitive data are held to a more rigorous quality standard, screening data should be of sufficient quality to support the intermediate decision in which they are used. For data to be categorized as definitive, they should be accompanied by a series of quality control measures. These QA/QC activities are outlined in the matrix. Screening data cannot be used to make final decisions (such as no further action or response complete) or for risk assessment, site closure, or listing (or delisting) on the National Priorities List (NPL); however, they can be used to make *intermediate* decisions, even those that are significant, such as decisions regarding placement of monitoring wells or estimates of extent of contamination.

Examples of Appropriate Use of Screening Data for Intermediate Decisions

- During project scoping to narrow down an analyte list.
- During soil removal to identify when the removal is getting close to cleanup objectives. Screening data can indicate when definitive samples should be taken to confirm achievement of cleanup goals.
- During process control functions when construction is underway and engineering adjustments are made to optimize treatment.
- During the remedial investigation to determine well placement.

Although screening data are used only for preliminary or intermediate decisions, the quality of the data is still very important. To

ensure that screening data meet project quality objectives (PQOs), positive controls should be used to verify that the analysis will detect contaminants in samples when they are present. The purpose of using positive controls is to eliminate false negatives. Examples of positive control samples include a laboratory-fortified blank at the reporting limit, a proficiency test (PT) sample, or a manufacturer-supplied positive control. In addition, confirmatory analyses using definitive data are a minimum activity for screening data to confirm results.

Definitive data are held to a more rigorous quality standard and are used to make final decisions such as level or existence of risk, response complete, or site closure. In general, *definitive data* refers to analytical data of known quality, concentration, and level of uncertainty, and those levels of quality and uncertainty are consistent with the specifications for the decision to be made. **In assessing the usability of definitive data for the decision to be made, it is important to recognize that acceptable quality and certainty in the data *points* does not mean that the data *set* can be used. For the data set to be usable, the data points (including sample location and procedures) should meet criteria of representativeness, completeness, and comparability.** These criteria are set during the planning stage, when the PQOs are established and sampling design rationale is developed.

Examples of Appropriate Use of Definitive Data for Final Decisions

- For listing of a site on the National Priorities List.
- For a determination that no further action is required.
- To identify whether any unacceptable risk is present (risk assessment).
- To confirm achievement of cleanup goals.
- For compliance sampling of air or water discharges.

2.2 Role of Data Quality Indicators in Selecting QA/QC Samples

The *Uniform Federal Policy for Implementing Environmental Quality Systems* (UFP) defines data quality indicators as:

> ***...the quantitative statistics and qualitative descriptors that are used to interpret the degree of acceptability or utility of data to the user. The principal data quality indicators are precision, accuracy, representativeness, comparability, completeness, and sensitivity.***

Under Superfund, numerous QC samples are typically specified during investigation and cleanup, with limited knowledge of what the benefits to data quality are. It is the view of the QA Matrix Workgroup that these QC samples are collected and analyzed at significant cost, and the information they convey may be either repetitive, not used, or interpreted incorrectly. The workgroup analyzed all the possible types of QC samples currently required and related their contributions to data quality indicators.

Tables A-1 through A-4 in Appendix A outline the contributions that the types of QC samples make to understanding each DQI. The accompanying charts assist in the evaluation of QC samples and explain which activities measure specific indicators at various points in the analytical process. The results of the evaluation of DQIs are reflected in the QA/QC activities identified in the matrix. Appendix B defines each QC sample (as well as other terms), including those not identified as minimum activities at CERCLA sites.

2.2.1 Introduction to Data Quality Indicators

The workgroup considered the DQIs of **precision, accuracy, and sensitivity** when determining which QC samples should be minimum specifications. In addition, the workgroup examined the DQI of **comparability** and identified the qualitative measures that can be used to evaluate the achievement of this indicator.

- **Precision** is the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves. Precision is usually expressed as standard deviation, variance, or range, in either absolute or relative terms (NELAC, 1999). Examples of QC samples for precision include field duplicates, laboratory duplicates, matrix spike duplicates, analytical replicates, and surrogates.
- **Accuracy** is the degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components, which are due to sampling and analytical operations (EPA, 1993). Examples of QC samples for accuracy include PT samples, matrix spikes, laboratory control samples (LCSs), and equipment blanks. The contamination subset of accuracy refers to measurements that indicate contamination of a sample. These consist of blanks, which indicate equipment contamination or method errors.
- **Representativeness** is a measure of the degree to which data accurately and precisely represent a characteristic of a population, a parameter variation at a sampling point, a process condition, or an environmental condition (EPA, 1998).
- **Comparability** is the degree to which different methods, data sets, and/or decisions agree or can be represented as similar. Comparability describes the confidence (expressed qualitatively or quantitatively) that two data sets can contribute to a common analysis and interpolation (EDRG-5).
- **Sensitivity** is the capability of a test method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest (NELAC, 1999). Examples of QC samples for determining sensitivity include laboratory-fortified blanks, a method detection limit study, and initial calibration low standards at the quantitation limit. Ultimately, sensitivity is a derived measure that represents values that can be differentiated with some degree of statistical confidence.

2.2.2 Minimum QC Samples and Data Quality Indicators

The workgroup determined each QC sample's value using the known information concerning the QC sample's contribution to measuring precision, accuracy, contamination subset (bias) of accuracy, and sensitivity. Because quality control checks are currently required and impose significant costs, the workgroup attempted to identify which of those checks are not cost-effective, that is, which provide very little additional information on the quality of the data or only duplicate the information.

Each quality control check found in Appendix A was evaluated using the following criteria:

- Provides overall measurement of accuracy, precision, etc.
- Identifies critical sources of error
- Is an operational requirement
- Is considered not useful to other QC samples or is redundant

QC samples that provided the best overall measure of data quality and identified critical sources of error were kept as minimum QA/QC activities. Other quality control check samples may be added on a project-specific basis but are not minimum specifications for every project. Those QC samples that were identified as an operational requirement were not listed as minimum activities in the matrix. It was assumed that those samples would be collected and analyzed as part of standard procedure. (The exception is the matrix spike for inorganics, which is listed in the QA matrix in order to stress that the sample is for inorganics and not organics.) Table 1 presents the results of the evaluation of QC samples using DQIs. (Definitions in Appendix B provide further explanation of each QC sample.)

The issue of **comparability** is addressed through several types of QC samples. **Split samples** can contribute to the determination of comparability; however, it is the view of the QA Matrix Workgroup that a split sample (see definition in Appendix B) is useful only when accompanied by a batch-specific proficiency testing (PT) sample. Without the associated PT sample, the only information obtained from split samples is that the results of the samples are different; no acceptance criteria for that difference are available. Therefore, split samples are not a minimum QA/QC activity. They can be added on a project-specific basis and should be used only when accompanied by a PT sample for proper evaluation of results.

2.2.3 Proficiency Testing Samples

In its examination of QC samples that measure DQIs, the QA matrix workgroup felt that batch-specific PT samples are an excellent measure of the overall accuracy of the data associated with a batch. The comment column in Table 1 provides a description of the criteria by which the specification for a batch-specific PT sample was evaluated. Table A-2 in Appendix A, describes the manner in which a PT sample contributes to an understanding of accuracy.

A PT sample is:

A sample, the composition of which is unknown to the laboratory or analyst, which is provided to that analyst or laboratory to assess capability to produce results within acceptable criteria.

2.2.3.1 *Guidelines*

Batch-specific PT samples are a minimum activity for almost all definitive data uses in the CERCLA program (see Tables 4 and 5 for details). There are different kinds of batch-specific PT samples that can be used. The specification in the QA matrix is that the project team should decide whether a full volume PT sample (one that comes ready for preparation and analysis with the other samples) or an ampulated PT sample (one that comes in liquid form and must be diluted prior to preparation and analysis) should be used for a specific project. (See Appendix B for more complete definitions.) The full volume PT sample can be double blind (the laboratory does not know it is a PT sample and therefore does not know the contaminants and concentrations) or single blind (known to be a PT sample, but with unknown contaminants and concentrations). The ampulated PT sample can only be single blind.

Table 1. Evaluation of QC Samples by DQI

QC Sample	Overall Measure of DQI	Identifies Critical Sources of Error	Operational Requirement	Not Useful	Comment
PRECISION					
Co-located Field Duplicate					The definition of field duplicate was clarified by differentiating between subsample (in which one sample is collected, homogenized, and then split into two or more portions) and co-located samples (in which two different samples are collected from the same location). In the view of the workgroup, the co-located field duplicate contributes more information about the measurement precision of the sampling process, including the sampling equipment and heterogeneity of the site; therefore, it is a minimum activity in the matrix.
Lab Duplicate		**inorganics organics**			The workgroup felt that laboratory duplicates are usually useful only for inorganic compounds. In order to have a comparable measure of precision for organic compounds, surrogate spikes should be evaluated if no target analytes are detected.
Internal Standard					
Subsample Field Duplicate					See comment for co-located field duplicate.
Matrix Spike Duplicate					Matrix spike duplicates are a commonly used QC sample; however, the results are largely a function of the spiking procedure (e.g., number of analytes spiked, length of time between spiking and extraction). It is the view of the workgroup that they are not an effective measurement of precision in environmental media.
Analytical Replicate					

Table 1. Evaluation of QC Samples by DQI (Continued)

QC Sample	Overall Measure of DQI	Identifies Critical Sources of Error	Operational Requirement	Not Useful	Comment
			ACCURACY		
Batch-specific Proficiency Testing Sample					There are several different types of proficiency testing samples: site-specific, ampulated, and full-volume. In the view of the workgroup, the site-specific PT sample provides the most complete measurement of accuracy. However, it is by far the most expensive and complicated to obtain, and acceptance criteria must be established. Therefore, site-specific PT samples are not a minimum activity. The ampulated PT sample is the least expensive, is readily available, and has known acceptance criteria. It can only be single blind, therefore it provides a less complete measurement of accuracy. The full-volume PT sample is in between the two other types as far as both cost and measurement of accuracy is concerned. It is readily available and has known acceptance criteria and the possibility of being double blind. The specification for a batch-specific PT sample in the matrix is for either an ampulated or full volume PT sample. The specific type should be determined for the project at the scoping meeting (see Section 2.2.3 for further explanation).
Matrix Spike	**inorganics**		**inorganics**	**organics**	The workgroup felt that a matrix spike is more appropriate for inorganic compounds than for organic compounds, while a surrogate spike can be used for organic compounds only. The surrogate spike can identify matrix effects as long as the surrogates properly mimic the analytes of concern.
Surrogate Spike	**organics**				See comment for matrix spike.
Laboratory Control Sample					

Table 1. Evaluation of QC Samples by DQI (Continued)

QC Sample	Overall Measure of DQI	Identifies Critical Sources of Error	Operational Requirement	Not Useful	Comment
Calibrations and Instrument Performance Checks					
ACCURACY (CONTAMINATION SUBSET)					
Equipment Blank	**non-dedicated equipment**				The equipment blank is performed only once a day, and therefore cannot track contamination in every cooler. In addition, it cannot quantify effects for soil. If nondedicated equipment is used, then the equipment blank is useful to test the decontamination technique of those doing the sampling.
Field Blank					Field blank is a new term created by the workgroup (see definition in Appendix B). It refers to a trip blank that is prepared in the field and can be used for all methods, not just volatile compounds as with the VOA trip blank. A field blank in every cooler will identify if contamination has occurred, whether the equipment is dedicated or not.
Method Blank					
Instrument Blank					
Bottle Blank					
Storage Blank					
Reagent Blank					
VOA Trip Blank					See comment for field blank.

Table 1. Evaluation of QC Samples by DQI (Continued)

QC Sample	Overall Measure of DQI	Identifies Critical Sources of Error	Operational Requirement	Not Useful	Comment
Temperature Blank					Temperature monitoring of samples is important; however, a temperature blank indicates the temperature of the samples only at the arrival time. There is no way to know if the samples were warmer at some time and then cooled down immediately before delivery. The workgroup felt that instead of a temperature blank, a temperature indicator is needed to notify the recipients when the samples have exceeded a maximum temperature. (See definition of shipping container temperature blank in Appendix B.) The exact nature of the device can be determined by the client.
SENSITIVITY					
Laboratory-fortified Blank					
Initial Calibration Low Standard					At the quantitation limit.
Method Detection Limit Study					Method detection limit studies are useful for prequalification purposes; however, in the view of the workgroup, they are not useful for interpreting data on a sample-by-sample basis. Therefore, they are not a minimum activity in the matrix.

The IDQTF determined that it is not necessary for PT samples to be double blind samples. The rationale for this is that if a PT sample is run with each batch, there is no time for an analyst to give it special attention, even if they know it is a PT sample. In addition, the IDQTF decided that there will be no specification that the PT sample be a site-specific sample, made out of the environmental media present at the site. The cost and time associated with characterizing the site matrix and establishing acceptance criteria were thought to be too extensive, providing little added value for the purpose.[1]

The contaminants and concentrations to be included in the batch-specific PT sample and the acceptance criteria by which the results will be evaluated should be established during the project scoping stage.

2.2.3.2 *Availability*

The QA Matrix Workgroup felt that in order for a batch-specific PT sample to be useful, it should be in a media similar to that of the environmental samples being tested (e.g., a solid or aqueous media). Ideally, it should also contain contaminants of concern at the site and, if possible, concentrations of concern at the site. The IDQTF recognizes that the number of PT samples available that fit each site's specifications may be limited. Therefore, although the QA matrix lists batch-specific PT samples as a minimum activity, full implementation of this may take some time. Project-specific implementation of this activity should be conducted using common sense, recognizing that initially it will not always be possible to meet the specifications.

2.2.3.3 *Cost and Effectiveness Issues*

The IDQTF recognizes that the specification for batch-specific PT samples can add significant additional cost to the project's analytical budget. Therefore, the use of batch-specific PT samples can be used as a replacement for data validation step IIa of analytical laboratory results. Discussion of the use of PT samples to streamline data validation is contained in Section 2.3.3.2.

2.3 Stages of Data Collection, Analysis, and Use

QA/QC activities in the matrix are grouped by five project stages: planning, field sampling, on-site field measurements, off-site/fixed lab measurements, and data review. Although field sampling, on-site field measurements, and off-site/fixed lab measurements have similar QA/QC activities, the difference is that the first stage deals with collection of samples, while the latter two stages deal with sample analysis. Thus, if a QA/QC activity is a minimum activity in one stage, it will also be a minimum activity in the other two.

2.3.1 Planning

The planning stage in the QA matrix reflects the scoping and preparation stage of a project. This stage has specifications for a systematic planning process, sampling design rationale,

[1]If the project team agrees to the use of site-specific PT samples (because they are already in use and readily available such as at DOE sites), it is not necessary to analyze an additional ampulated or full volume PT sample.

development and approval of a QAPP, scheduling, and training. For the convenience of the matrix user, planning activities involving definitive data and screening data are listed separately in the tables; however, the matrix organization does not demand two different processes (meetings, QAPPs, etc.). The planning stage for a single project should be one coordinated effort that addresses the use of both screening data and definitive data.

2.3.2 Sampling and Analysis

The sampling and analysis phases of the QA matrix are separated into three sections. **Field sampling** activities take place during sample collection. **On-site field measurements** occur when analysis is performed on-site, such as *in-situ* testing (e.g., with a temperature probe), on-site analysis (e.g., turbidity readings), and field trailer/mobile lab analysis. **Off-site/fixed lab measurements** occur when analysis is performed in an off-site laboratory. The sampling and analysis stages include minimum specifications for specific QC samples such as field blanks or matrix spikes. In addition, these stages have guidelines for preparation, such as inspection and maintenance of supplies, and guidelines for review or oversight (e.g., internal/external audits). The three stages have almost identical QA/QC activities, but the CERCLA phase and data use activities will differ depending on whether the data type is definitive or screening.

2.3.3 Data Review

The QA matrix outlines a variety of activities for data review. Because EPA, DoD, and DOE define data review steps differently, the QA Matrix Workgroup forged a common understanding of the components of data review.

2.3.3.1 *Data Review — Definitions and Scope*

The workgroup defined data review as:

> ***The process of examining and/or evaluating data to varying levels of detail and specificity by personnel within the data management process. It includes, but is not limited to, data verification, data validation, and data usability assessment.***

The data review process is separated into three steps. Each of these three steps has specific activities that should be completed by a data reviewer.

- **Step I: Sampling and analysis verification (completeness check)** – confirmation by examination and provision of objective evidence that the specified requirements (sampling and analytical) have been completed.
- **Step II: Sampling and analysis validation (IIa – Compliance with methods, procedures, and contracts; IIb – Comparison with quality objectives of QAPP)** – confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled. Data validation is a sampling and analytical process evaluation that includes evaluating compliance with method, procedure, or contract requirements, and extends to criteria based upon the quality objectives (e.g., PQOs) developed in the QAPP. The purpose of data validation is to

assess and document the performance associated with the sampling and analysis to determine the quality of specified data.

- **Step III: Data usability assessment** – determination of the adequacy of data, based on the results of data validation and verification, for the decisions being made. The usability assessment step involves assessing and documenting whether the process execution and resulting data meet quality objectives based on criteria established in the QAPP.

Table 2 describes the objectives, scope, and steps of data review associated with each process term. The table identifies where the scope of the terms or the steps involved in the process are expansions of current practice. Those expansions are based on the following:

- The terms *data verification* and *data validation* apply to field sampling activities as well as to the analytical component of data generation.
- Data validation assesses not only compliance with method, procedure, and contract requirements, but also assesses compliance with QAPP-specific requirements.
- Data usability assessments are one of the minimum activities of data review for all CERCLA phases and data uses. This is the final step of data review, and as such, it assesses whether the data are suitable as a basis for decisions.

Table 2. Data Review Process Summary

Process Term	Objective	Scope	Data Review Step
Data Verification	Review to see if data required for the project is available.	– Sampling* – Analysis	I. Completeness check
Data Validation	• Assess and document performance of the field sample collection process. • Assess and document performance of the analytical process.	– Sampling* – Analysis	IIa. Compliance with method, procedure, and contract requirements IIb. Comparison with project quality criteria from the QAPP*
Data Usability Assessment*	Assess and document data usability to meet project quality objectives.	– Sampling – Analysis	III. Assessment of usability of data by considering project quality objectives and the decision to be made*

* Denotes where the scope of the term used or the steps involved are expansions of current practice.

2.3.3.2 *Implementation of Data Review Activities*

Specifications for the implementation of the data review process acknowledge two important issues:

- Data review should take into account the relationship of the data reviewer to the entity that originally performed the work.
- Data review steps can be streamlined in a variety of ways.

Relationship of Data Reviewer to Generation of Data

Implementation of the data review process should take into account the relationship of the data reviewer to the entity that performed the work (generated the data). This relationship requires a balance between the need to maintain the integrity of the process (e.g., the entity who generates the analytical or field data may have a conflict of interest in conducting the review and therefore may be precluded from performing the review) and ensuring that those with the appropriate expertise are involved in the data review step. The relationship of the data reviewer to each step of the data review process is described below:

- **Step I (data verification):** Both the data generator and client are expected to perform data verification.

- **Step II (data validation):**
  - *Step IIa (Compliance with Methods, Procedures, and Contracts)*. Data validation associated with step IIa should be conducted by an entity at least one step removed from the entity that generated the data (field or analytical). In general this will mean that data validation step IIa of analytical data will be conducted outside the laboratory, while the validation of the field sampling activities will be conducted by entities working for the prime contractor who are not responsible for the field sampling activities.

  - *Step IIb (Comparison to Quality Objectives of QAPP)*. Data validation step IIb will usually involve those that have been involved in the development of the QAPP and/or the project, but may also include a reviewing entity that is separate from the entities conducting the work.

- **Step III (data usability assessment):** The data usability assessment should be performed by the full project team, although it may also involve people outside the project execution.

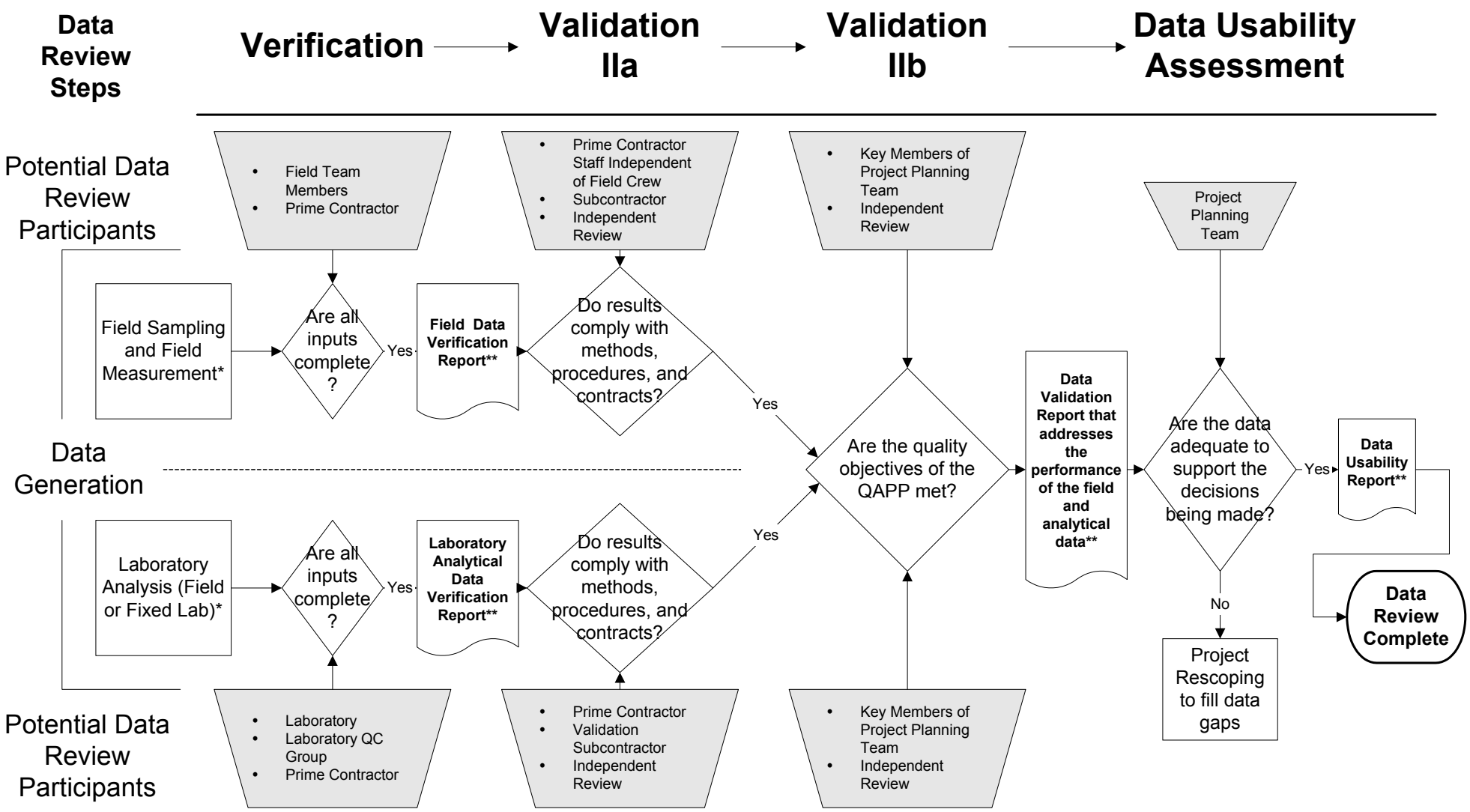
Figure 2 presents a flow chart of the data review process and the potential participants in each step.

Streamlining Data Review

Streamlining of the data review process (streamlining data review) is meant to reduce time and costs while still confirming the quality of the data. Thus, any streamlining option should recognize that:

- The type and amount of data reviewed should be sufficient to develop a clear understanding of the quality of the data.
- The practice of reviewing a subset of data (or of a data indicator such as a successful PT sample) as a substitute for review of all data should be reevaluated if problems are detected that call into question the quality of a data set.

Figure 2. Potential Participants in the Data Review Process



*Data review of field activity and laboratory analysis can occur separately or at the same time and by the same personnel, if appropriate.

**Does not have to be separate report - may be part of RI/FS or other document.

NOTE: A "no" answer to the questions will result in corrective action, flagging, or contact with the client.

Streamlined data review occurs when efficiencies are created in the data review process by:

- Looking at a subset of data that is representative of a larger universe.
- Examining the data in an alternate manner (e.g., use of a successful batch of specific PT samples as a substitute for validation of some compliance indicators).

Different EPA Regions, DoD components, and DOE facilities have negotiated a variety of streamlining options with different projects. The decision as to the nature and type of streamlining to be conducted will be made on a site-by-site or facility-by-facility basis and documented in the QAPP. The QAPP should also contain decision criteria that allow for revision of the initial streamlining plan. For example, decision criteria contained in the QAPP could specify that if problems are identified in the investigation, then streamlining cannot occur. Other factors may also lead to a revision of the initial streamlining decision, such as intense political interest and concern on the part of the community. The QAPP should contain a clause that prohibits streamlining when conditions are not optimal.

As noted in Section 2.2.3, Proficiency Testing Samples, the specification for batch-specific PT samples was added to foster streamlining of data validation. It is anticipated that successful batch-specific PT sample results can replace a specification for the analytical portion of data validation step IIa (compliance with method, procedural and contractual requirements). In order for this streamlining activity to be implemented, the project team should agree on the contaminants and concentrations to be included in the batch-specific PT sample (ampulated or full volume), as well as the acceptance criteria by which the results will be evaluated, at the project scoping stage. If established criteria are achieved, then it will not be necessary to conduct data validation activities (step IIa) on analytical data. Data validation step IIa for sampling activities will still be needed since the batch-specific PT samples cannot substitute for data validation of these activities. Chapter 5 of the UFP-QAPP Manual contains further criteria for and direction on streamlining opportunities (see Section 5.5).

2.4 Organization of the QA Matrix Based on the CERCLA Process

The QA matrix uses a combination of CERCLA phases and data uses as organizing principles:

- CERCLA phases (e.g., remedial investigation) are used to organize investigation activities of the CERCLA process.
- Data uses organize the post-ROD or post-construction phases of the CERCLA process. This was in part because DoD, DOE, and EPA use different terms to describe the same CERCLA phase, and because the construction phases have unique activities associated with them.

2.4.1 Investigation Phases

Below is a list of the CERCLA phases for investigation or preconstruction activities, a brief explanation of the purpose of each phase, and the data uses that fall under each phase. In the phases for which data use subcategories are not warranted, only the CERCLA phase appears in the matrix (such as for site inspection).

- **Preliminary Assessment (PA)** – uses only secondary data (interviews, observations, historical data, etc.). These data are used to assess the likelihood of contamination in an area and the probable nature of the contamination. This phase requires only screening data. Since no new data are generated during this phase, it differs from the other phases in that there are no QA/QC activities except under the data review and usability assessment stages of the project.
- **Site Inspection (SI)** – consists of on-site data gathering to determine whether there is a release or potential release of contaminants and the nature of the associated threats to human health and the environment. This phase uses both definitive and screening data and is not divided by data uses. SI data may be used for the following outcomes or decisions: removal, further investigation, hazard ranking system (HRS), or no further action. Decisions for further investigation and removal can be made with screening data if they are intermediate decisions; however, the other decisions should use definitive data only.
- **Remedial Investigation (RI)** – consists of data gathering undertaken by the lead agency or responsible party to determine the nature and extent of risk to human health or the environment due to a contaminant release or potential release. In addition, the data collected during the RI phase may be used to assess various remediation alternatives. The RI phase emphasizes data collection and site characterization, and both screening and definitive data can be used. The QA/QC activities for screening data are not differentiated by data use; however, definitive data contain distinctions between nature of contamination, extent of contamination, risk assessment of human health, and risk assessment of ecological factors.
- **Feasibility Study (FS): Extent of Contamination** – is undertaken by the lead agency to develop and evaluate options for a remedial action. The only additional type of data collection and use in the FS phase is for understanding the extent of contamination. Otherwise the study depends on data collected during other CERCLA phases (generally the RI). This phase uses definitive data only.
- **Treatability Studies** – are performed at bench or pilot scale. These studies model the treatment system to simulate the remedial technology selected to treat the waste encountered at the site. Bench-scale studies use a composition similar to the waste on a site in order to demonstrate whether the system is effective. Pilot studies use real waste found at a treatment site in order to model parameters for performance, design, and operation. The two types of treatability studies have identical QA/QC activities. Screening and definitive data may be used at different stages of the treatability study process. Screening data can be used to provide daily operational information or when the process is reaching steady state.
- **Non-Time-Critical (NTC) Removal** – the phase that involves implementation and evaluation of removal actions that can be initiated more than 6 months after contamination is identified. An engineering evaluation/cost analysis (EE/CA) is used to determine risk and select cleanup alternatives in this phase. (Note: Because of the project-specific nature of emergency [time-critical] cleanups, it is not possible to define QA/QC activities for time-critical removal actions that would allow for the necessary amount of flexibility. Minimum QA/QC activities for time-critical removals should be defined on a project-specific basis. For this reason, only NTC removals are addressed in the matrix.)

2.4.2 Construction, Post-construction, and Post-ROD Phases

Construction is the project phase during which a remedial action is implemented. Some projects do not require construction but may require monitoring or other activities using sampling and analysis. The post-construction and post-ROD phases include monitoring and operation and maintenance (O&M) of the remedial action. To examine the critical processes and QA/QC activities for these phases, the workgroup established common nomenclature for the different stages and milestones in the process. Once the proper correlation between EPA and DoD terms was made, all QA/QC needs were identified for each phase of the process. (Note: In these phases, activities are differentiated by data use, rather than CERCLA phase.)

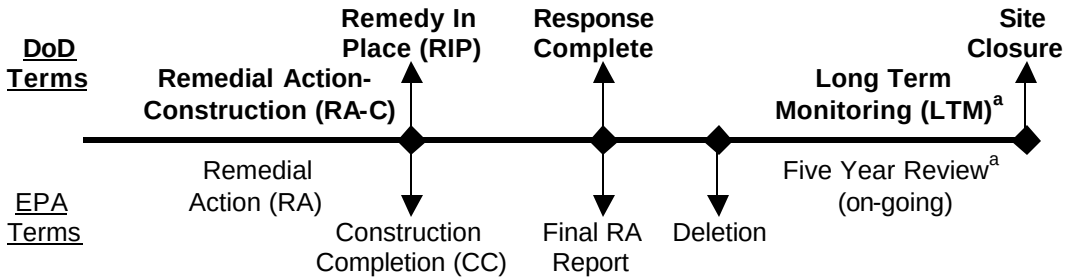
Table 3 presents the major construction, post-construction, and post-ROD phases, with a brief summary of the purpose and data uses that would be applicable to each phase. To demonstrate the correlation in nomenclature between EPA and DoD, timelines of remedy scenarios (treatment and off-site disposal, removal and off-site disposal, containment, and groundwater and surface water restoration) were illustrated (see Figure 3).

Table 3. Steps of the Major Construction, Post-construction, and Post-ROD Phases

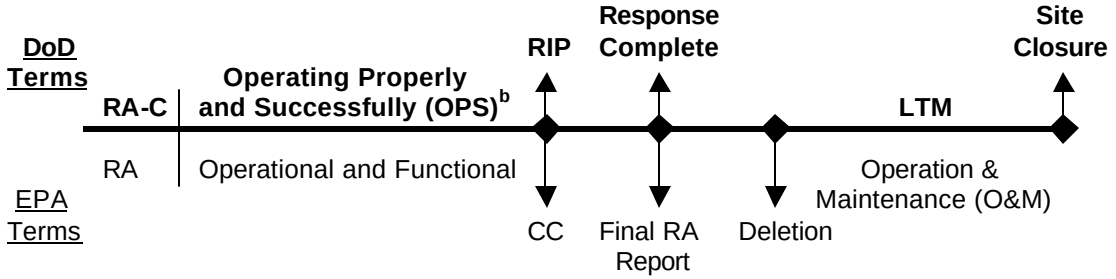
Purpose	Data Uses	EPA Term	DoD Term
Build the remedy (uses engineering data only).	Not applicable to the QA matrix	Remedial action (RA)	Remedial action-construction (RA-C)
Determine if the remedy is working correctly.	– Process control – Process analysis	Operational and functional, and construction complete	Operating properly and successfully (OPS), and remedy in place (RIP)
Verify that the cleanup goal has been achieved.	Confirmation sampling	Final RA report	Response complete
Implement and maintain the remedy over an extended period of time.	– Compliance monitoring – Process control – Monitoring program effectiveness and optimization	Long-term remedial action (LTRA), and operation and maintenance (O&M)	Remedial action-operation (RA-O), and long-term monitoring (LTM)
Ensure that the remedy remains effective.	– Monitoring program effectiveness and optimization – Effectiveness monitoring – Compliance monitoring	Operation and maintenance (O&M) or five-year review	Long-term monitoring (LTM)
Ensure that site cleanup goals and monitoring requirements have been met.	No new data collected; uses data from long-term monitoring or response-complete phases.	Deletion	Site closure

Figure 3. Example Remedy Scenarios and Comparable EPA/DoD Terminology

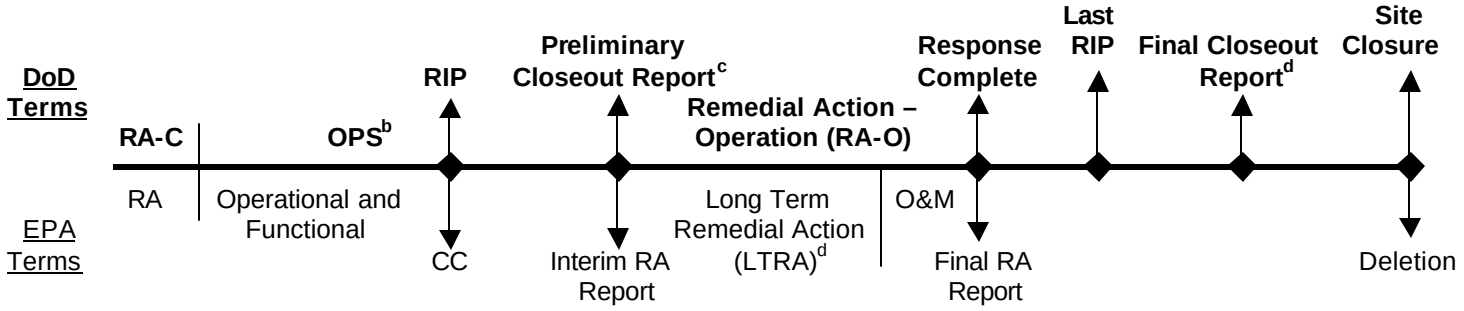
On-Site Soil Treatment and Off-Site Disposal



Containment Remedy



Groundwater and Surface Water Restoration



[a] If level greater than that of unrestricted use.
[b] BRAC
[c] If final RA at NPL installation.
[d] 10 years, if fund-financed.

From the identification of data uses, the workgroup identified six unique data uses: process analysis, process control, confirmation sampling, monitoring program effectiveness and optimization, compliance determination, and effectiveness monitoring. These data uses are the major categories for the construction, post-construction, and post-ROD phases in the matrix. They are explained in further detail below.

- **Construction: Process Analysis** – is categorized as a construction data use and involves testing to determine whether the remedy is operating properly and as designed, and falls under the operational and functional phase. Data generated here may eventually lead to the commissioning decision of remedy in place (RIP). Both screening and definitive data are acceptable for the process analysis data use. Definitive data have the highest possible level of data quality and should be used for the final OPS (operating properly and successfully, DoD) determination, as well as the RIP decision. Screening data can be used for intermediate decisions.
- **Construction: Process Control** – is a construction data use that takes place during the RA-O/O&M and operational and functional phases. During the operational and functional phase, sophisticated process control is used to prove that the selected technology can operate properly to reach cleanup levels and to optimize the remedy. In the RA-O/O&M phase, process control is used to monitor influent, effluent, and secondary waste streams; optimize the remedial system; and troubleshoot and monitor natural attenuation. Process control specifications apply to both constructed and in-situ remedies. It does not demand the highest level of data quality and therefore is not appropriate for compliance testing. During process control, parameters may be measured in the field, but not necessarily at a fixed analytical laboratory. Both screening and definitive data can be used for process control.
- **Construction and Post-construction: Confirmation Sampling** – is both a construction and post-construction data use that needs definitive data. The data are used to substantiate a response-complete decision (cleanup goal achieved) and may be used to confirm the results of process analysis. The highest level of data quality is demanded. For example, confirmation sampling should be undertaken when excavation is nearing completion to determine that cleanup levels have been reached. It also should be used to confirm that treatment goals have been achieved.
- **Post-construction: Monitoring Program Effectiveness/Optimization** – uses both screening and definitive data and is used in the RA-O/O&M (including monitored natural attenuation) and long-term monitoring phases. The data generated are used to examine the sampling frequency, content, and location of long-term monitoring programs. Data may be used to reduce the frequency of sampling or to refine the analyte list. They may also be used to track trends and model the change in contamination.
- **Post-construction: Compliance Determination** – uses definitive data to confirm that specific regulatory criteria are met. The data are used to measure contaminant levels in effluent, secondary waste streams, disposed waste, backfill, and so forth during the RA-O/O&M phase. The data are also used for permit compliance and monitored natural attenuation. Data generated for compliance determination during the long-term monitoring phase can be used for waste disposal, permit compliance, and five-year reviews. The highest level of data quality is needed for this data use.

- **Post-construction and Post-ROD: Effectiveness Monitoring** – uses definitive data during the long-term monitoring phase to examine whether a no-action decision remains appropriate and to model and evaluate trends in contamination levels associated with both action and no-action decisions. The data are used to evaluate whether the remedy is operating properly and efficiently and to determine if there is any benefit to changing operational parameters. The highest level of data quality is needed for this data use.

3.0 THE QA MATRIX: MINIMUM ACTIVITIES FOR QA/QC UNDER CERCLA

The QA matrix in this section lays out the minimum activities to be used on CERCLA projects. This section identifies the QA/QC activities appropriate to the CERCLA phase, data use, project stage, and type of data (screening or definitive) being generated. For a complete understanding of the QA/QC activities specified, refer to Section 2 of this compendium. The minimum specifications presented in the QA matrix should be used in conjunction with the development of a project-specific QAPP and project quality objectives.

3.1 Reading the Matrix

The matrix is organized first according to investigation and construction/post-construction/ post-ROD phases. The first set of tables is for the investigation phases, the second set is for post-investigation (construction, post-construction, and post-ROD) phases. CERCLA phases (SI, RI, construction, etc.) and appropriate data uses are listed across the top of the matrix (the columns of the matrix). Those CERCLA phase-data use combinations are differentiated by data type, that is, as screening or definitive. Each table is divided into project stages (planning, sampling, usability, etc.). Each project stage has a list of specific QA/QC activities, which make up the rows of the matrix. Therefore each cell in the matrix represents a CERCLA phase (and data use) and QA/QC activity. For each CERCLA phase-data use combination, QA/QC activities that should be performed in order to meet minimum data quality guidelines are marked with a check (✔). Those QA/QC activities that are not minimum specifications for a specific CERCLA phase-data use combination are identified by a dash (–).

3.2 Key Definitions

During the development of the QA matrix, the workgroup created or refined definitions of terms used in this compendium. Matrix users should become familiar with the glossary in Appendix B to ensure consistent understanding and application by matrix users. Definitions for specific QC samples and other terminology used throughout the document can be found in the glossary and occasionally in the text.

3.3 Applying the Matrix

The activities presented in the matrix are minimum QA/QC activities for the collection and analysis of data at CERCLA sites. The purpose of a minimum set of activities is to streamline the planning and QAPP-writing process. With the baseline specifications established by the QA matrix, a project team can begin establishing project-specific quality objectives and identifying the specific acceptance criteria that relate to the PQOs.

Data quality is a project-specific variable that can be defined using the systematic planning process for a specific project. A project team may determine that, based on project-specific needs, other QA/QC activities should be added. The QA matrix serves as an appendix to the UFP-QAPP and is meant to complement the specifications of that document. Beyond the actual QA/QC activities in the matrix, additional descriptive information appropriate to the project-specific quality

objectives, such as sampling frequency, sample location, and acceptance criteria, should be developed.

During the pre-QAPP coordination stage of the planning process (i.e., planning or scoping meeting), stakeholders should determine which CERCLA phases and data uses are relevant to the site and what type of data will be collected. Then they should refer to the matrix for the list of minimum QA/QC activities appropriate for those CERCLA phases and data uses. At that point, other QA/QC activities may be added, as appropriate, and the details of how to implement all the QA/QC activities should be defined (i.e., what the specific procedures and criteria will be for each activity).

3.4 QA Matrix

In the QA matrix that follows, the first set of tables is for the investigation phase and includes the following CERCLA phases:

- Preliminary assessment
- Site inspection
- Remedial investigation
- Feasibility study
- Treatability study
- Non-time-critical removals

Site investigations, non-time-critical removals, remedial investigations, and treatability studies may use both screening and definitive data; however, preliminary assessments should use only screening data, and feasibility studies should use only definitive data.

The second set of tables is for post-investigation phases, that is, the construction, post-construction, and post-ROD phases. The construction phase involves two different data uses: process analysis and process control. The following data uses are possible during the post-construction phase:

- Confirmation sampling
- Compliance determination
- Monitoring program effectiveness/optimization
- Effectiveness monitoring

Both screening data and definitive data are allowed for construction (process analysis and process control) and monitoring program effectiveness/optimization during post-construction. Only definitive data is acceptable for confirmation sampling, compliance determination, and effectiveness monitoring during post-construction activities.

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Table 4. QA Matrix: INVESTIGATION PHASES

Data Use:	Preliminary Assessment	Site Investigation	Remedial Investigation (all data uses)	Treatability Study	Non-Time Critical Removal	Site Investigation	RI: Nature of Contamination	RI: Extent of Contamination	RI: Risk Assessment - Human Health	RI: Risk Assessment - Ecological	FS: Extent of Contamination	Treatability Study	Non-Time Critical Removal
QA/QC Activity	**SCREENING**					**DEFINITIVE**							
PLANNING													
P1. Requirement for a Systematic Planning Process (e.g., establishment of Project Quality Objectives [PQOs], Measurement Quality Objectives [MQOs])	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
P2. Requirement for a Pre-QAPP Coordination with all Stakeholders (e.g., planning meeting, scoping meeting)	--	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
P3. Requirement for a Sampling Design Rationale (including both rationale for sampling locations and techniques)	--	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
P4. Requirement for a Quality Assurance Project Plan (QAPP) **	--	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
P5. Requirement for internal QAPP review and approval procedures	--	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
P6. Requirement for QAPP modifications and/or change-control procedures [oo]	--	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
P7. Documented Schedule and Budget	--	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
P8. Documented Project Personnel Training, Education, and Experience Criteria and Standard Operating Procedures (SOPs) for verifying qualifications (Includes identification of all project-specific appropriate Quality Assurance [QA] Personnel, including QA Officer)	--	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

**Can be found in other documents (e.g. O&M plan, treatability plan). It does not need to be a stand-alone document.

[oo] Applies to stand-alone QAPPs and those that are part of larger documents.

✔ = Activity is required; -- = Activity is not required;

Table 4. QA Matrix: INVESTIGATION PHASES

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QA/QC Activity	**SCREENING**					**DEFINITIVE**							
FIELD SAMPLING													
S1. Requirement for inspection and acceptance of supplies	--	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
S2. Criteria for field sampling supplies, preservation, and sample container quality control (including verification SOPs)	--	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
S3. Description of equipment/instrumentation and personnel qualifications	--	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
S4. Criteria for acceptable field sampling equipment performance	--	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
S5. Requirement for maintenance and verification of ongoing acceptable field sampling equipment performance (including SOPs, e.g., verification of testing, inspection, calibration)	--	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
S6. Criteria for cleaning and decontamination of field sampling equipment (including SOPs)	--	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
S7. Requirement for project-specific field sampling performance criteria	--	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
S8. Requirement for documentation and record keeping (e.g., Field logbooks)	--	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
S9. Procedures (e.g., SOPs, workplan) for field sampling management (Documentation to answer “Is the sample traceable?”, e.g., sample location, transport, storage, and shipping procedures)	--	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
S10. Procedures (e.g., SOPs, workplan) for field sample collection (Documentation to answer "Was the sample collected properly?", e.g., sample collection methods)	--	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

✔ = Activity is required; -- = Activity is not required;

Table 4. QA Matrix: INVESTIGATION PHASES

Data Use:	Preliminary Assessment	Site Investigation	Remedial Investigation (all data uses)	Treatability Study	Non-Time Critical Removal	Site Investigation	RI: Nature of Contamination	RI: Extent of Contamination	RI: Risk Assessment - Human Health	RI: Risk Assessment - Ecological	FS: Extent of Contamination	Treatability Study	Non-Time Critical Removal
QA/QC Activity	**SCREENING**					**DEFINITIVE**							
FIELD SAMPLING (CONT'D)													
S11. Documentation of data management, handling, and tracking controls		✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
S12. Requirement for Co-located Field duplicate samples (including acceptance criteria)						✔		✔	✔	✔	✔		✔
S13. Requirement for Field blanks (for dedicated and non-dedicated equipment)						✔	✔	✔	✔	✔	✔		✔
S14. Requirement for Field equipment or rinse blanks (for non-dedicated equipment)						✔	✔	✔	✔	✔	✔		✔
S15. Requirement for Cooler Temperature Indicator (**Perform as necessary**)						✔	✔	✔	✔	✔	✔		✔
S16. Requirement for Matrix spike (MS) (inorganics only) (including acceptance criteria)						✔	✔	✔	✔	✔	✔		✔
S17. Requirement for Internal Pre-startup readiness review		✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
S18. Requirement for Internal field sampling audits and/or oversight		✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
S19. Requirement for External field sampling audits and/or oversight						✔	✔	✔	✔	✔	✔		✔
S20. Requirement for Positive Control Sample, if required by measurement criteria		✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

Table 4. QA Matrix: INVESTIGATION PHASES

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QA/QC Activity	**SCREENING**					**DEFINITIVE**							
ON-SITE FIELD MEASUREMENTS													
F1. Requirement for inspection and acceptance of supplies	--	✔	✔	--	✔	✔	✔	✔	✔	✔	✔	✔	✔
F2. Criteria for field supplies, calibration standards, and sample container quality control	--	✔	✔	--	✔	✔	✔	✔	✔	✔	✔	✔	✔
F3. Descriptions of equipment/instrumentation and personnel qualifications	--	✔	✔	--	✔	✔	✔	✔	✔	✔	✔	✔	✔
F4. Criteria for acceptable field measurement/analysis equipment/instrument performance	--	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
F5. Requirement for maintenance/verification of field measurement/analysis equipment performance	--	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
F6. Criteria for cleaning and decontamination of field measurement/analysis equipment	--	✔	✔	--	✔	✔	✔	✔	✔	✔	✔	✔	✔
F7. Requirement for project-specific measurement/analysis performance criteria	--	✔	✔	--	✔	✔	✔	✔	✔	✔	✔	✔	✔
F8. Documentation of measurement/analysis quality system	--	✔	✔	--	✔	✔	✔	✔	✔	✔	✔	✔	✔
F9. Requirement for documentation and record keeping (e.g., analyst logs, field logs)	--	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
F10. Procedures (e.g., SOPs, workplan) related to sample management (Documentation to answer "Is the measurement traceable?")	--	✔	✔	--	✔	✔	✔	✔	✔	✔	✔	✔	✔
F11. Procedures (e.g., SOPs, workplan) related to sample measurement/analysis (including preparation and cleanup)	--	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

✔ = Activity is required; -- = Activity is not required;

Table 4. QA Matrix: INVESTIGATION PHASES

Data Use:	Preliminary Assessment	Site Investigation	Remedial Investigation (all data uses)	Treatability Study	Non-Time Critical Removal	Site Investigation	RI: Nature of Contamination	RI: Extent of Contamination	RI: Risk Assessment - Human Health	RI: Risk Assessment - Ecological	FS: Extent of Contamination	Treatability Study	Non-Time Critical Removal
QA/QC Activity	**SCREENING**					**DEFINITIVE**							
ON-SITE FIELD MEASUREMENTS (CONT'D)													
F12. Description of data deliverables/data package content and generation procedures		✔	✔		✔	✔	✔	✔	✔	✔	✔	✔	✔
F13. Documentation of data management, handling, and tracking controls		✔	✔		✔	✔	✔	✔	✔	✔	✔	✔	✔
F14. Requirement for Laboratory duplicate samples to measure intralaboratory precision						✔	✔	✔	✔	✔	✔	✔	✔
F15. Requirement for Matrix spike (MS) (inorganics only)						✔	✔	✔	✔	✔	✔		✔
F16. Comparability criteria for confirmatory analyses (compare screening and definitive data)		✔	✔		✔								
F17. Requirement for Confirmatory Analyses		✔	✔		✔								
F18. Requirement for Proficiency Testing samples - Batch-Specific						✔	✔	✔	✔	✔	✔		✔
F19. Requirement for pre-startup measurement/ analysis readiness review		✔	✔		✔	✔	✔	✔	✔	✔	✔	✔	✔
F20. Requirement for internal measurement/analysis audits and/or oversight		✔	✔		✔	✔	✔	✔	✔	✔	✔	✔	✔
F21. Requirement for external measurement/analysis audits and/or oversight						✔	✔	✔	✔	✔	✔	✔	✔
F22. Requirement for Positive Control Sample, if required by measurement criteria		✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

✔ = Activity is required; -- = Activity is not required;

Table 4. QA Matrix: INVESTIGATION PHASES

Data Use:	Preliminary Assessment	Site Investigation	Remedial Investigation (all data uses)	Treatability Study	Non-Time Critical Removal	Site Investigation	RI: Nature of Contamination	RI: Extent of Contamination	RI: Risk Assessment - Human Health	RI: Risk Assessment - Ecological	FS: Extent of Contamination	Treatability Study	Non-Time Critical Removal
QA/QC Activity	**SCREENING**					**DEFINITIVE**							
OFF-SITE/FIXED LAB MEASUREMENTS													
L1. Requirement for inspection and acceptance of supplies		✔	✔	--	✔	✔	✔	✔	✔	✔	✔	✔	✔
L2. Criteria for supplies, calibration standards, and sample container quality control (including verification SOPs)		✔	✔		✔	✔	✔	✔	✔	✔	✔	✔	✔
L3. Descriptions of equipment/instrumentation and personnel requirements	--	✔	✔	--	✔	✔	✔	✔	✔	✔	✔	✔	✔
L4. Criteria for acceptable laboratory equipment/ instrument performance	--	✔	✔	--	✔	✔	✔	✔	✔	✔	✔	✔	✔
L5. Requirement for maintenance and verification of ongoing acceptable laboratory equipment/instrument performance (including SOPs)	--	✔	✔	--	✔	✔	✔	✔	✔	✔	✔	✔	✔
L6. Criteria for cleaning and decontamination of equipment and instruments (including SOPs)	--	✔	✔	--	✔	✔	✔	✔	✔	✔	✔	✔	✔
L7. Requirement for project-specific measurement/ analysis performance criteria	--	✔	✔	--	✔	✔	✔	✔	✔	✔	✔	✔	✔
L8. Documentation of a laboratory quality system (e.g., Laboratory QA Manual)	--	✔	✔	--	✔	✔	✔	✔	✔	✔	✔	✔	✔
L9. Requirement for documentation and record keeping (e.g., analyst logs)	--	✔	✔	--	✔	✔	✔	✔	✔	✔	✔	✔	✔
L10. Procedures (e.g., SOPs, workplan) related to laboratory sample management (Documentation to answer "Is measurement traceable?")	--	✔	✔	--	✔	✔	✔	✔	✔	✔	✔	✔	✔

Table 4. QA Matrix: INVESTIGATION PHASES

Data Use:	Preliminary Assessment	Site Investigation	Remedial Investigation (all data uses)	Treatability Study	Non-Time Critical Removal	Site Investigation	RI: Nature of Contamination	RI: Extent of Contamination	RI: Risk Assessment - Human Health	RI: Risk Assessment - Ecological	FS: Extent of Contamination	Treatability Study	Non-Time Critical Removal
QA/QC Activity	**SCREENING**					**DEFINITIVE**							
OFF-SITE/FIXED LAB MEASUREMENTS (CONT'D)													
L11. Procedures (e.g., SOPs, workplan) related to sample analysis, including preparation and cleanup (Documentation to answer "Was the measurement in control?")		✔	✔		✔	✔	✔	✔	✔	✔	✔	✔	✔
L12. Description of data deliverables/data package content and generation procedures		✔	✔		✔	✔	✔	✔	✔	✔	✔	✔	✔
L13. Documentation of data management, handling, and tracking controls		✔	✔		✔	✔	✔	✔	✔	✔	✔	✔	✔
L14. Requirement for Laboratory duplicate samples (including acceptance criteria)						✔	✔	✔	✔	✔	✔	✔	✔
L15. Requirement for Matrix spike (MS) (inorganics only) (including acceptance criteria)					--	✔	✔	✔	✔	✔	✔		✔
L16. Comparability criteria for confirmatory analyses (Includes comparisons between screening and definitive data and/or two definitive methods – reflected through separate columns of the matrix)		✔	✔		✔								
L17. Requirement for Confirmatory Analyses		✔	✔		✔								
L18. Requirement for Proficiency Testing samples - Pre-qualification (including acceptance criteria)												✔	
L19. Requirement for Proficiency Testing samples – Batch-specific (including acceptance criteria)						✔	✔	✔	✔	✔	✔		✔
L20. Requirement for Pre-startup laboratory audits/ readiness reviews		✔	✔		✔								

✔ = Activity is required; -- = Activity is not required;

Table 4. QA Matrix: INVESTIGATION PHASES

Data Use:	Preliminary Assessment	Site Investigation	Remedial Investigation (all data uses)	Treatability Study	Non-Time Critical Removal	Site Investigation	RI: Nature of Contamination	RI: Extent of Contamination	RI: Risk Assessment - Human Health	RI: Risk Assessment - Ecological	FS: Extent of Contamination	Treatability Study	Non-Time Critical Removal
QA/QC Activity	**SCREENING**					**DEFINITIVE**							
OFF-SITE/FIXED LAB MEASUREMENTS (CONT'D)													
L21. Requirement for Internal laboratory audits and/or oversight		✔	✔		✔	✔	✔	✔	✔	✔	✔	✔	✔
L22. Requirement for External laboratory audits and/or oversight						✔	✔	✔	✔	✔	✔		✔
L23. Requirement for Positive Control Sample, if required by measurement criteria		✔	✔		✔	✔	✔	✔	✔	✔	✔	✔	✔
DATA REVIEW													
D1. Laboratory internal data review SOPs		✔	✔		✔	✔	✔	✔	✔	✔	✔	✔	✔
D2. Laboratory data deliverable requirements (specifications for hard copy and/or electronic data deliverables) – Tabular sample results with QC results													
D3. Laboratory data deliverable requirements (specifications for hard copy and/or electronic data deliverables) – Tabular sample results, QC results, and raw data		✔	✔		✔	✔	✔	✔	✔	✔	✔	✔	✔
D4. Requirement for internal laboratory verification of meeting data deliverable requirements and project-specific MQO requirements		✔	✔		✔	✔	✔	✔	✔	✔	✔	✔	✔
D5. Requirement for sampling and analysis verification (completeness review) of sampling and analytical data deliverables.	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
D6. Requirement for review of findings from sampling and analysis verification and preparation of report	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
D7. Requirement for sampling and analysis validation (assessment of sampling and analytical data against technical requirements)	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
D8. Criteria for sampling and analysis validation	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

✔ = Activity is required; -- = Activity is not required;

Table 4. QA Matrix: INVESTIGATION PHASES

Data Use:	Preliminary Assessment	Site Investigation	Remedial Investigation (all data uses)	Treatability Study	Non-Time Critical Removal	Site Investigation	RI: Nature of Contamination	RI: Extent of Contamination	RI: Risk Assessment - Human Health	RI: Risk Assessment - Ecological	FS: Extent of Contamination	Treatability Study	Non-Time Critical Removal
QA/QC Activity	**SCREENING**					**DEFINITIVE**							
DATA REVIEW (CONT'D)													
D9. Requirement for documentation of results of sampling and analysis validation (e.g., exceedances and exceptions)	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
D10. Requirement for (regulatory) review of data assessment report						✔	✔	✔	✔	✔	✔	✔	✔
D11. Requirement to reconvene project team (see P2) to perform data usability assessment	--	--	--	--	--	✔	✔	✔	✔	✔	✔	✔	✔
D12. Requirement for data usability assessment and documentation of results by project team	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
D13. Requirement for preparation and review of final data usability report	--	--	--	--	--	✔	✔	✔	✔	✔	✔	✔	✔

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Table 5. QA Matrix: POST-ROD PHASES

Data Use:	Process Analysis	Process Control	Monitoring Program Effectiveness/Optimization	Confirmation Sampling	Compliance Determination	Process Analysis	Process Control	Monitoring Program Effectiveness/Optimization	Effectiveness Monitoring
QA/QC Activity	**SCREENING**			**DEFINITIVE**					
PLANNING									
P1. Requirement for a Systematic Planning Process (e.g., establishment of Project Quality Objectives [PQOs], Measurement Quality Objectives [MQOs])	✔	✔	✔	✔	✔	✔	✔	✔	✔
P2. Requirement for a Pre-QAPP Coordination with all Stakeholders (e.g., planning meeting, scoping meeting)	✔	--	✔	✔	✔	✔	--	✔	✔
P3. Requirement for a Sampling Design Rationale (including both rationale for sampling locations and techniques)	✔	--	✔	✔	✔	✔	✔	✔	✔
P4. Requirement for a Quality Assurance Project Plan (QAPP) **	✔	✔	✔	✔	✔	✔	✔	✔	✔
P5. Requirement for internal/external QAPP review and approval procedures	✔	--	✔	✔	✔	✔	✔	✔	✔
P6. Requirement for QAPP modifications and/or change-control procedures ºº	✔	--	✔	✔	✔	✔	✔	✔	✔
P7. Documented Schedule and Budget	✔	--	✔	✔	✔	✔	✔	✔	✔
P8. Documented Project Personnel Training, Education, and Experience Criteria and Standard Operating Procedures (SOPs) for verifying qualifications (Includes identification of all project-specific appropriate Quality Assurance [QA] Personnel, including QA Officer)	✔	✔	✔	✔	✔	✔	✔	✔	✔

** Can be found in other documents (e.g. O&M plan, treatability plan). It does not need to be a stand-alone document.

Process Control. Requirement for internal QAPP review and approval procedures only.

ºº Applies to stand-alone QAPPs and those that are part of larger documents.

✔ = Activity is required; -- = Activity is not required;

Table 5. QA Matrix: POST-ROD PHASES

QA/QC Activity	SCREENING			DEFINITIVE					
Data Use:	Process Analysis	Process Control	Monitoring Program Effectiveness/Optimization	Confirmation Sampling	Compliance Determination	Process Analysis	Process Control	Monitoring Program Effectiveness/Optimization	Effectiveness Monitoring
FIELD SAMPLING									
S1. Requirement for inspection and acceptance of supplies	✔	✔	✔	✔	✔	✔	✔	✔	✔
S2. Criteria for field sampling supplies, preservation, and sample container quality control (including verification SOPs)	✔	--	✔	✔	✔	✔	✔	✔	✔
S3. Description of equipment/instrumentation and personnel qualifications	✔	--	✔	✔	✔	✔	✔	✔	✔
S4. Criteria for acceptable field sampling equipment performance	✔	--	✔	✔	✔	✔	✔	✔	✔
S5. Requirement for maintenance and verification of ongoing acceptable field sampling equipment performance (including SOPs, e.g. verification of testing, inspection, calibration)	✔	--	✔	✔	✔	✔	✔	✔	✔
S6. Criteria for cleaning and decontamination of field sampling equipment (including SOPs)	✔	--	✔	✔	✔	✔	✔	✔	✔
S7. Requirement for project-specific field sampling performance criteria	✔	--	✔	✔	✔	✔	--	✔	✔
S8. Requirement for documentation and record keeping (e.g., Field logbooks)	✔	✔	✔	✔	✔	✔	✔	✔	✔
S9. Procedures (e.g., SOPs, workplan) for field sampling management (Documentation to answer “Is the sample traceable?”, e.g., sample location, transport, storage, and shipping procedures)	--	--	✔	✔	✔	✔	✔	✔	✔
S10. Procedures (e.g., SOPs, workplan) for field sample collection (Documentation to answer "Was the sample collected properly?", e.g., sample collection methods)	✔	✔	✔	✔	✔	✔	✔	✔	✔
S11. Documentation of data management, handling, and tracking controls	--	--	✔	✔	✔	✔	--	✔	✔

✔ = Activity is required; -- = Activity is not required;

Table 5. QA Matrix: POST-ROD PHASES

Data Use:	SCREENING			DEFINITIVE					
QA/QC Activity	Process Analysis	Process Control	Monitoring Program Effectiveness/Optimization	Confirmation Sampling	Compliance Determination	Process Analysis	Process Control	Monitoring Program Effectiveness/Optimization	Effectiveness Monitoring
FIELD SAMPLING (CONT'D)									
S12. Requirement for Co-located Field duplicate samples (including acceptance criteria)				✔	✔	✔	✔	✔	✔
S13. Requirement for Field blanks (for dedicated and non-dedicated equipment)				✔	✔	✔	N	✔	✔
S14. Requirement for Field equipment or rinse blanks (for non-dedicated equipment)				✔	✔	✔	N	✔	✔
S15. Requirement for Cooler Temperature Indicator (**Perform as necessary**)				✔	✔	✔	N	✔	✔
S16. Requirement for Matrix spike (MS) (inorganics only) (including acceptance criteria)				✔	✔	✔	N	✔	✔
S17. Requirement for Pre-startup readiness review	✔	✔	✔	✔	✔	✔	✔	✔	✔
S18. Requirement for Internal field sampling audits and/or oversight	✔	✔	✔	✔	✔	✔	✔	✔	✔
S19. Requirement for External field sampling audits and/or oversight				✔	✔	✔		✔	✔
S20. Requirement for Positive Control Sample, if required by measurement criteria	✔	✔	✔	✔	✔	✔	✔	✔	✔
ON-SITE FIELD MEASUREMENTS									
F1. Requirement for inspection and acceptance of supplies	✔	--	✔	✔	✔	✔	✔	✔	✔
F2. Criteria for field supplies, calibration standards, and sample container quality control	✔	--	✔	✔	✔	✔	✔	✔	✔
F3. Descriptions of equipment/instrumentation and personnel qualifications	✔	--	✔	✔	✔	✔	✔	✔	✔

N = Normally not needed for Process Control; however, if the parameter requires preservation and blanks, use good analytical practice to determine if appropriate.

Table 5. QA Matrix: POST-ROD PHASES

Data Use:	Process Analysis	Process Control	Monitoring Program Effectiveness/Optimization	Confirmation Sampling	Compliance Determination	Process Analysis	Process Control	Monitoring Program Effectiveness/Optimization	Effectiveness Monitoring
QA/QC Activity	**SCREENING**			**DEFINITIVE**					
ON-SITE FIELD MEASUREMENTS (CONT'D)									
F4. Criteria for acceptable field measurement/ analysis equipment/instrument performance	✔	✔	✔	✔	✔	✔	✔	✔	✔
F5. Requirement for maintenance/verification of field measurement/ analysis equipment performance	✔	✔	✔	✔	✔	✔	✔	✔	✔
F6. Criteria for cleaning and decontamination of field measurement/analysis equipment	✔	--	✔	✔	✔	✔	✔	✔	✔
F7. Requirement for project-specific measurement/analysis performance criteria	✔	--	✔	✔	✔	✔	✔	✔	✔
F8. Documentation of measurement/analysis quality system	✔	✔	✔	✔	✔	✔	✔	✔	✔
F9. Requirement for documentation and record keeping (e.g., analyst logs, field logs)	✔	✔	✔	✔	✔	✔	✔	✔	✔
F10. Procedures (e.g., SOPs, workplans) related to sample management (Documentation to answer "Is the measurement traceable?")	--	--	✔	✔	✔	✔	✔	✔	✔
F11. Procedures (e.g., SOPs, workplans) related to sample measurement/analysis (including preparation and cleanup)	✔	✔	✔	✔	✔	✔	✔	✔	✔
F12. Description of data deliverables/data package content and generation procedures	--	--	✔	✔	✔	✔	--	✔	✔
F13. Documentation of data management, handling, and tracking controls	--	--	✔	✔	✔	✔	--	✔	✔

Table 5. QA Matrix: POST-ROD PHASES

QA/QC Activity	SCREENING			DEFINITIVE					
	Process Analysis	Process Control	Monitoring Program Effectiveness/Optimization	Confirmation Sampling	Compliance Determination	Process Analysis	Process Control	Monitoring Program Effectiveness/Optimization	Effectiveness Monitoring
Data Use:									
ON-SITE FIELD MEASUREMENTS (CONT'D)									
F14. Requirement for Laboratory duplicate samples to measure intralaboratory precision	✔	--	--	✔	✔	✔	✔	✔	✔
F15. Requirement for Matrix spike (MS) (inorganics only)	--	--	--	✔	✔	✔	--	✔	✔
F16. Comparability criteria for confirmatory analyses (compare screening and definitive data)	✔	--	✔	--	--	--	--	--	--
F17. Requirement for Confirmatory Analyses	✔	--	✔	--	--	--	--	--	--
F18. Requirement for Proficiency Testing samples - Batch-Specific	--	--	--	✔	✔	✔	--	✔	✔
F19. Requirement for pre-startup measurement/analysis readiness review	✔	--	✔	✔	✔	✔	✔	✔	✔
F20. Requirement for internal measurement/analysis audits and/or oversight	✔	--	✔	✔	✔	✔	✔	✔	✔
F21. Requirement for external measurement/analysis audits and/or oversight	--	--	--	✔	✔	✔	--	✔	✔
F22. Requirement for Positive Control Sample, if required by measurement criteria	✔	✔	✔	✔	✔	✔	✔	✔	✔
OFF-SITE/FIXED LAB MEASUREMENTS									
L1. Requirement for inspection and acceptance of supplies	✔	--	✔	✔	✔	✔	✔	✔	✔
L2. Criteria for supplies, calibration standards, and sample container quality control (including verification SOPs)	✔	--	✔	✔	✔	✔	✔	✔	✔
L3. Descriptions of equipment/ instrumentation and personnel requirements	✔	--	✔	✔	✔	✔	✔	✔	✔
L4. Criteria for acceptable laboratory equipment/ instrument performance	✔	--	✔	✔	✔	✔	✔	✔	✔
L5. Requirement for maintenance and verification of ongoing acceptable laboratory equipment/instrument performance (including SOPs)	✔	--	✔	✔	✔	✔	✔	✔	✔

✔ = Activity is required; -- = Activity is not required;

Table 5. QA Matrix: POST-ROD PHASES

Data Use:	SCREENING			DEFINITIVE					
QA/QC Activity	Process Analysis	Process Control	Monitoring Program Effectiveness/Optimization	Confirmation Sampling	Compliance Determination	Process Analysis	Process Control	Monitoring Program Effectiveness/Optimization	Effectiveness Monitoring
OFF-SITE/FIXED LAB MEASUREMENTS (CONT'D)									
L6. Criteria for cleaning and decontamination of equipment and instruments (including SOPs)	✔		✔	✔	✔	✔	✔	✔	✔
L7. Requirement for project-specific measurement/analysis performance criteria	✔	--	✔	✔	✔	✔	✔	✔	✔
L8. Documentation of a laboratory quality system (e.g., Laboratory QA Manual)	✔	--	✔	✔	✔	✔	✔	✔	✔
L9. Requirement for documentation and record keeping (e.g., analyst logs)	✔	--	✔	✔	✔	✔	✔	✔	✔
L10. Procedures (e.g., SOPs, workplan) related to laboratory sample management (Documentation to answer "Is the measurement traceable?")	✔	--	✔	✔	✔	✔	✔	✔	✔
L11. Procedures (e.g., SOPs, workplan) related to sample analysis, including preparation and cleanup (Documentation to answer "Was the measurement in control?")	✔	--	✔	✔	✔	✔	✔	✔	✔
L12. Description of data deliverables/data package content and generation procedures	✔	--	✔	✔	✔	✔	✔	✔	✔
L13. Documentation of data management, handling, and tracking controls	✔	--	✔	✔	✔	✔	✔	✔	✔
L14. Requirement for Laboratory duplicate samples (including acceptance criteria)	✔	--	--	✔	✔	✔	✔	✔	✔
L15. Requirement for Matrix spike (MS) (inorganics only) (including acceptance criteria)	--	--	--	✔	✔	✔	--	✔	✔

Table 5. QA Matrix: POST-ROD PHASES

QA/QC Activity	SCREENING			DEFINITIVE					
Data Use:	Process Analysis	Process Control	Monitoring Program Effectiveness/Optimization	Confirmation Sampling	Compliance Determination	Process Analysis	Process Control	Monitoring Program Effectiveness/Optimization	Effectiveness Monitoring
OFF-SITE/FIXED LAB MEASUREMENTS (CONT'D)									
L16. Comparability criteria for confirmatory analyses (Includes comparisons between screening and definitive data and/or two definitive methods – reflected through separate columns of the matrix)	✔		✔						
L17. Requirement for Confirmatory Analyses	✔		✔						
L18. Requirement for Proficiency Testing samples - Pre-qualification (including acceptance criteria)									
L19. Requirement for Proficiency Testing samples – Batch-specific (including acceptance criteria)				✔	✔	✔	✔	✔	✔
L20. Requirement for Pre-startup laboratory audits/readiness reviews	✔		✔						
L21. Requirement for Internal laboratory audits and/or oversight	✔		✔	✔	✔	✔	✔	✔	✔
L22. Requirement for External laboratory audits and/or oversight				✔	✔	✔	✔	✔	✔
L23. Requirement for Positive Control Sample, if required by measurement criteria	✔		✔	✔	✔	✔	✔	✔	✔
DATA REVIEW									
D1. Laboratory internal data review SOPs	--	--	✔	✔	✔	✔	✔	✔	✔
D2. Laboratory data deliverable requirements (specifications for hard copy and/or electronic data deliverables) – Tabular sample results with QC results	--	--	--	--	--	--	✔	--	--
D3. Laboratory data deliverable requirements (specifications for hard copy and/or electronic data deliverables) – Tabular sample results, QC results, and raw data	--	--	✔	✔	✔	✔	--	✔	✔

✔ = Activity is required; -- = Activity is not required;

Table 5. QA Matrix: POST-ROD PHASES

Data Use:	Process Analysis	Process Control	Monitoring Program Effectiveness/Optimization	Confirmation Sampling	Compliance Determination	Process Analysis	Process Control	Monitoring Program Effectiveness/Optimization	Effectiveness Monitoring
QA/QC Activity	**SCREENING**			**DEFINITIVE**					
DATA REVIEW (CONT'D)									
D4. Requirement for internal laboratory verification of meeting data deliverable requirements and project-specific MQO requirements	✔	--	✔	✔	✔	✔	✔	✔	✔
D5. Requirement for sampling and analysis verification (completeness review) of sampling and analytical data deliverables	✔	✔	✔	✔	✔	✔	✔	✔	✔
D6. Requirement for review of findings from sampling and analysis verification and preparation of report	✔	✔	✔	✔	✔	✔	✔	✔	✔
D7. Requirement for sampling and analysis validation (assessment of sampling and analytical data against technical requirements).	✔	✔	✔	✔	✔	✔	✔	✔	✔
D8. Criteria for sampling and analysis validation	✔	✔	✔	✔	✔	✔	✔	✔	✔
D9. Requirement for documentation of results of sampling and analysis validation (e.g., exceedances and exceptions)	✔	✔	✔	✔	✔	✔	✔	✔	✔
D10. Requirement for (regulatory) review of data assessment report.	--	--	--	✔	✔	✔	--	✔	✔
D11. Requirement to reconvene project team (see P2) to perform data usability assessment	--	--	--	✔	✔	✔	--	✔	✔
D12. Requirement for data usability assessment and documentation of results by project team	✔	✔	✔	✔	✔	✔	✔	✔	✔
D13. Requirement for preparation and review of final data usability report	--	--	--	✔	✔	✔	--	✔	✔

APPENDIX A

QC SAMPLES AND DATA QUALITY INDICATORS

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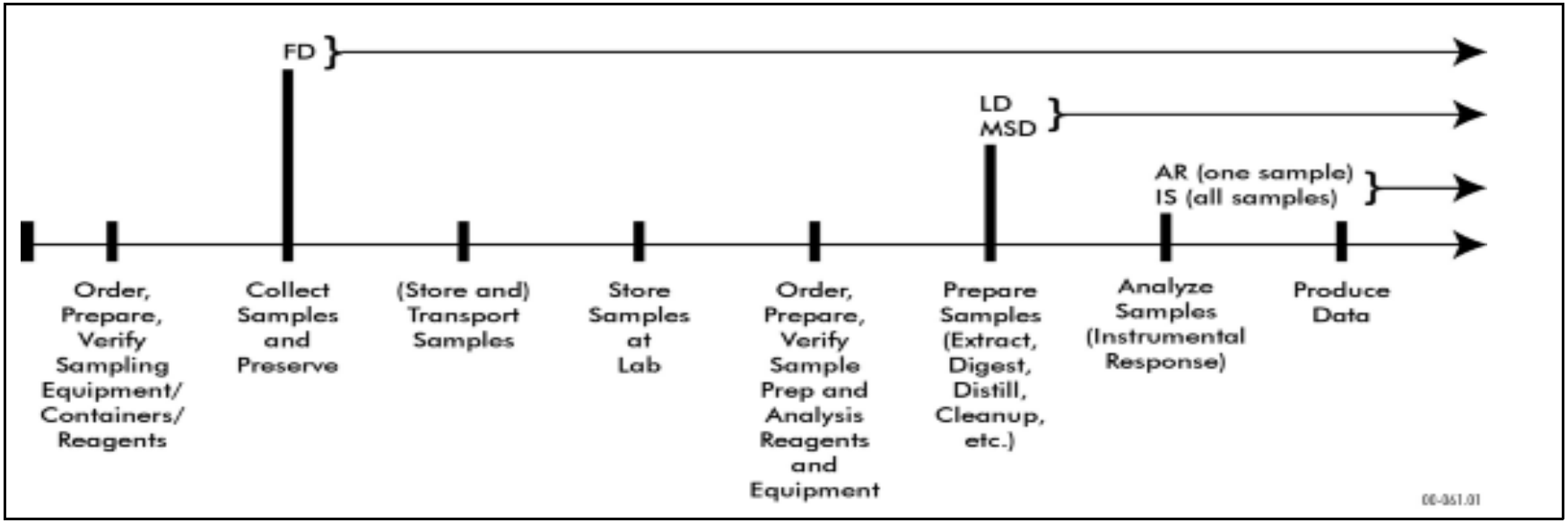
TABLE A-1. QC SAMPLES THAT CONTRIBUTE TO DETERMINING PRECISION

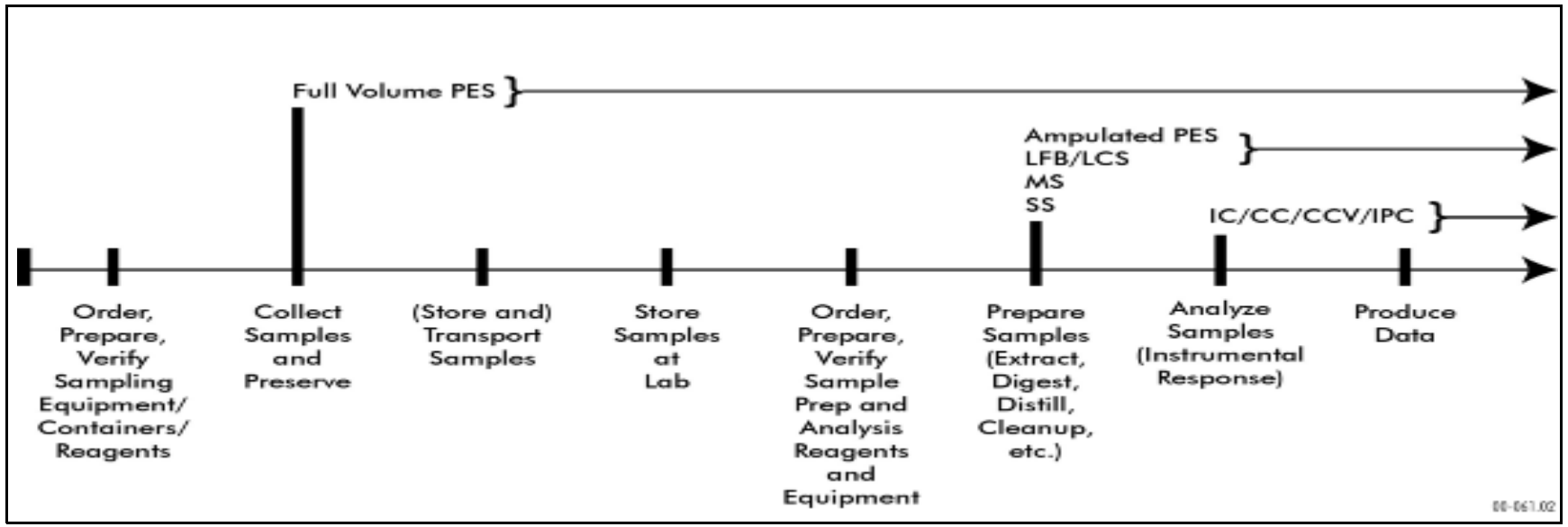
QC Measurement	Sampling Equipment	Sample Container	Preservation	Env. Media	Transport	Storage at Lab	Preparation Reagents	Preparation Equipment	Analysis Reagents	Analysis Equipment	Frequency	Additional Cost?
Field Duplicates (FD) - Co-located											5-10%	**Y**
Field Duplicates (FD) - Subsample											5-10%	**Y**
Laboratory Duplicates (LD)											5-10% (inorganics)	**N**
Matrix Spike Duplicates (MSD)											5-10% (organics)	**Y**
Analytical Replicates (AR)											Variable	**N**
Internal Standards (IS)											100% (GC/MS) Variable (others)	**N**



Note: Abbreviations are given in table.

TABLE A-2. QC SAMPLES THAT CONTRIBUTE TO DETERMINING ACCURACY

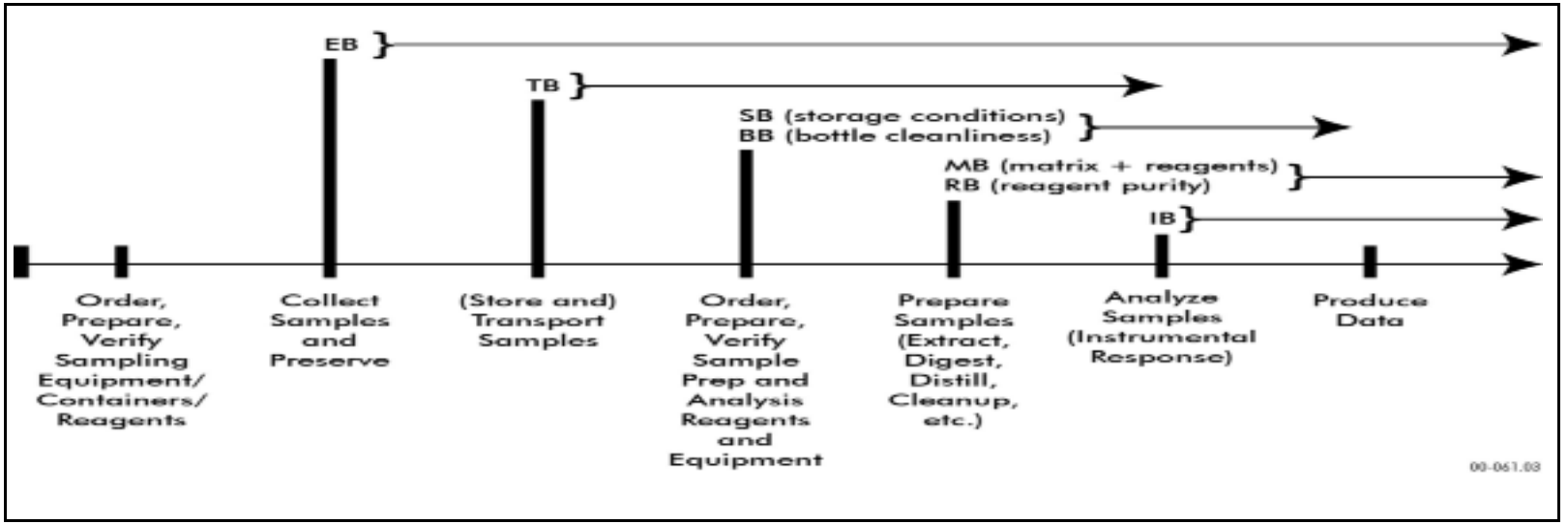
QC Measurement	Sampling Equipment	Sample Container	Preservation	Env. Media	Transport	Storage at Lab	Preparation Reagents	Preparation Equipment	Analysis Reagents	Analysis Equipment	Frequency	Additional Cost?
Site-Specific PT Sample											**Variable**	**Y**
Full-Volume PT Sample											**Variable**	**Y**
Ampulated PT Sample											**Variable**	**Y**
Matrix Spike (MS)											**5-10%**	**Y**
Surrogate Spikes (SS)											100% (organics)	**N**
Laboratory Control Sample (LCS)											5%	**N**
Initial Calibration/Continuing Calibration/Continuing Calibration Verification/Instrument Performance Check Sample (IC/CC/CCV/IPC)											Variable	**N**



Note: PES equivalent to PT (proficiency testing) sample. Other abbreviations are defined in table.

TABLE A-3. QC SAMPLES THAT CONTRIBUTE TO DETERMINING ACCURACY (CONTAMINATION SUBSET)

QC Measurement	Sampling Equipment	Sample Container	Preservation	Env. Media	Transport	Storage at Lab	Preparation Reagents	Preparation Equipment	Analysis Reagents	Analysis Equipment	Frequency	Additional Cost?
Equipment Blank (EB)											1 per day per type of sample equip.	Y
Volatile Trip Blank (TB)											1 per cooler of VOA	Y
Bottle Blank (BB)											1 per lot of bottles	Y
Storage Blank (SB)											1 per SDG	Y
Method Blank/Reagent Blank (MB/RB)											1 per batch (5%)	N
Instrument Blank (IB)											As needed	N
Shipping Container Temperature Blank											1 per cooler	N



Note: SDB = sample delivery group. Other abbreviations are defined in table.

TABLE A-4. QC SAMPLES THAT CONTRIBUTE TO DETERMINING METHOD SENSITIVITY

QC Measurement	Preparation Reagents	Preparation Equipment	Analysis Reagents	Analysis Equipment	Frequency	Additional Cost?
Laboratory-Fortified Blank (LFB) at Quantitation Limit					1 per sample delivery group (SDG)	Y
Method Detection Limit (MDL) Study					Annual	N
Initial Calibration Low Standard at Quantitation Limit[a]					Whenever calibration is performed	N

[a] Not run for ICP.

APPENDIX B

ACRONYMS AND DEFINITIONS

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Acronyms

ANSI/ASQC	American National Standards Institute/American Society for Quality Control
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DoD	Department of Defense
DOE	Department of Energy
DQI	Data quality indicator
EPA	Environmental Protection Agency
FS	Feasibility study
HRS	Hazard Ranking System
MQOs	Measurement quality objectives
IDQTF	Intergovernmental Data Quality Task Force
NPL	National priorities list
NTC	Non-time-critical
O&M	Operation and maintenance
PA	Preliminary assessment
PQOs	Project quality objectives
PT	Proficiency test
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
RI	Remedial investigation
ROD	Record of Decision
SI	Site investigation
SOPs	Standard operating procedures
SPP	Systematic planning process
UFP	Uniform Federal Policy

Definitions

Accuracy. The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias), components which are due to sampling and analytical operations. Examples of QC measures for accuracy include PT samples, matrix spikes, laboratory control samples (LCSs), and equipment blanks.

Analytical replicates (AR). Injecting multiple aliquots of the same sample extract or conducting multiple measurements on the same sample using the same analytical system to evaluate analytical precision.

Audit. A systematic and independent examination to determine whether quality activities and related results comply with planned arrangements and whether these arrangements are implemented effectively and are suitable to achieve objectives.

Blank. A sample subjected to the usual analytical or measurement process to establish a zero baseline or background value. A sample that is intended to contain none of the analytes of interest. A blank is used to detect contamination during sample handling, preparation, and/or analysis.

Bottle blank (BB). Sample designed to evaluate contamination introduced from the sample container(s) in a particular lot.

Comparability. The degree to which different methods, data sets, and/or decisions agree or can be represented as similar. Comparability describes the confidence that two data sets can contribute to a common analysis and interpolation.

Confirmatory analysis. The process of generating sufficient evidence to ensure that a result for a specific sample is valid. Analytes must be identified correctly in order to be quantified. The identity and quantity of residues should be confirmed. Analytical methods which lack specificity demand confirmation. This confirmation should be accomplished through an accompanying method with greater specificity.

Continuing calibration verification (CCV). The verification of the initial calibration that is required at periodic intervals during the course of an analytical shift. Continuing calibration verification applies to both external standard and internal standard calibration techniques, as well as to linear and nonlinear calibration models.

Contracting entity. Any organization or individual contracting to furnish services or items or to perform work.

Cooler temperature indicator. A device that monitors the temperature inside the sample cooler. Examples may include a continuously recording thermostat, a temperature strip that notes when a maximum temperature has been exceeded, or a shipping container temperature blank.

Data deliverable. Reports of analytical results from the laboratory. There are three levels of data deliverables, from most limited to most complete: (1) tabulated sample results; (2) tabulated sample results with QC results; and (3) tabulated sample results, QC results, and raw data printouts.

Data quality indicators. The quantitative statistics and qualitative descriptors that are used to interpret the degree of acceptability or utility of data to the user. The principal data quality indicators are precision, accuracy, representativeness, comparability, completeness, and sensitivity.

Data quality objectives (DQOs). Qualitative and quantitative statements derived from the DQO Process that clarify study objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors. DQOs will be used as the basis for establishing the quality and quantity of data needed to support decisions.

Data review. The process of examining and/or evaluating data to varying levels of detail and specificity by a variety of personnel who have different responsibilities within the data management process. It includes, but is not limited to, data verification, data validation, and data usability assessment.

Data usability assessment. The adequacy of data based upon the results of data validation and verification for the decisions being made. In the usability step, one should assess whether the process execution and resulting data meets quality objectives based on criteria established in the QAPP.

Definitive data. Analytical data of known quality, concentration, and level of uncertainty. The levels of quality and uncertainty of the analytical data are consistent with the requirements for the decision to be made. Suitable for final decision-making.

Equipment blank (EB). A sample of water free of measurable contaminants poured over or through decontaminated field sampling equipment that is considered ready to collect or process an additional sample. The purpose of this blank is to assess the adequacy of the decontamination process. Also called rinse blank or rinsate blank.

Field blank. A blank used to provide information about contaminants that may be introduced during sample collection, storage, and transport. A clean sample, carried to the sampling site, exposed to sampling conditions, returned to the laboratory, and treated as an environmental sample.

Field duplicate, co-located. Two or more separate portions collected from side-by-side locations at the same point in time and space so as to be considered identical. These separate samples are said to represent the same population and are carried through all steps of the sampling and analytical procedures in an identical manner. These samples are used to assess precision of the total method, including sampling, analysis, and site heterogeneity. This definition does not include a subsample field duplicate, which is one sample that is homogenized and then split into two or more portions.

Field duplicate, subsample. Similar to a split sample except the same laboratory analyzes both samples. The sample is homogenized before being divided into two or more portions. These samples do not assess site heterogeneity, only specific sample point heterogeneity.

Field measurements. Those activities associated with performing analyses or measurement in the field. They include in-situ testing (e.g., with a temperature probe), on-site analyses (e.g., turbidity readings), and field trailer/mobile lab analyses.

Field sampling. The set of procedures associated with the collection of environmental samples.

Holding time. The period of time a sample may be stored prior to its required analysis. While exceeding the holding time does not necessarily negate the veracity of analytical results, it causes the qualifying or "flagging" of any data not meeting all of the specified acceptance criteria.

Initial calibration (IC). Analysis of analytical standards at different concentrations that is used to define the linearity and dynamic range of the response of the analytical detector or method.

Initial calibration low standard. Calibration standard whose concentration is at the lowest value at which the analytical instrument is capable of producing acceptable qualitative and quantitative data; the lowest part of the calibration curve (i.e., the quantitation limit).

Instrument blank (IB). An aliquot of analyte-free water or solvent processed through the instrumental steps of the measurement process to determine the presence of carryover from the previous analysis. Analysis does not include any sample preparation.

Internal standards (IS). A standard added to a test portion of a sample in a known amount and carried through the entire determination procedure as a reference for calibrating and controlling the precision and bias of the applied analytical method.

Laboratory control sample (LCS). A sample of known composition prepared using reagent-free water or an inert solid that is spiked with analytes of interest at the midpoint of the calibration curve or at the level of concern. It is analyzed using the same sample preparation, reagents, and analytical methods employed for regular samples.

Laboratory duplicates (LD). Two or more representative portions taken from one homogeneous sample by the laboratory and analyzed in the same laboratory. Laboratory duplicate samples are quality control samples that are used to assess intralaboratory preparatory and analytical precision.

Laboratory fortified blank (LFB). A low-level LCS sample (e.g., at the quantitation limit) used to evaluate laboratory preparatory and analytical sensitivity and bias for specific compounds.

Matrix spike (MS). A sample prepared by adding a known concentration of a target analyte to an aliquot of a specific homogenized environmental sample for which an independent estimate of the target analyte concentration is available. The matrix spike is accompanied by an independent analysis of the unspiked aliquot of the environmental sample. For organics, the matrix spike is run in conjunction with a matrix spike duplicate. Spiked samples are used to determine the effect of the matrix on a method's recovery efficiency.

Matrix spike duplicate (MSD). A homogeneous sample used to determine the precision of the intralaboratory analytical process for specific analytes (organics only) in a sample matrix. Sample

is prepared simultaneously as a split with the matrix spike sample, as each is spiked with identical, known concentrations of targeted analyte(s).

Measurement Quality Objectives. Specified acceptance criteria used in a sampling and analysis plan and designed to produce the type, quality, and quantity of data that can be used to support site decision-making.

Method blank (MB). A sample of a matrix similar to the batch of associated samples (when available) in which no target analytes or interferences are present at concentrations that impact the analytical results. It is processed simultaneously with samples of similar matrix and under the same conditions as the samples.

Method detection limit (MDL) studies. A statistical determination that defines the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero.

Oversight. The oversight process involves independent (outside of work process) internal and external assessment of the quality system and projects for conformance with requirements, effectiveness of requirements in maintaining quality, and taking (or ensuring or effecting) appropriate corrective action.

Positive control sample. A prepared standard which undergoes an analytical procedure at a specified frequency for the purpose of providing comparison with an unknown sample based on specified criteria, thereby monitoring recovery to assure that a test and/or its components are working properly and producing correct or expected results.

Precision. The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves. Precision is usually expressed as standard deviation, variance, or range, in either absolute or relative terms. (NELAC) Examples of QC measures for precision include field duplicates, laboratory duplicates, matrix spike duplicates, analytical replicates, and internal standards.

Proficiency testing (PT) sample (sometimes called a performance evaluation (PE) sample). A sample, the composition of which is unknown to the laboratory or analyst, which is provided to that analyst or laboratory to assess capability to produce results within acceptable criteria. PT samples can fall into three categories: (1) prequalification, conducted prior to a laboratory beginning project work, to establish initial proficiency; (2) periodic (e.g., quarterly, monthly, or episodic) to establish ongoing laboratory proficiency; and (3) batch-specific, which is conducted simultaneously with analysis of a sample batch.

PT sample, ampulated. A PT sample that is received as a concentrate and must be diluted to volume before being treated as an analytical sample. It can only be single blind.

PT sample, full volume. A PT sample that is received by the laboratory ready to be treated as an analytical sample. It does not require dilution, therefore can be single or double blind.

PT sample, site-specific. A PT sample created using well-characterized contaminated media that is treated as an analytical sample by the laboratory to test its capabilities.

Project quality objectives (PQOs). Qualitative and quantitative statements derived from a Systematic Planning Process (e.g., the DQO Process defined in EPA QA/G-4) that clarify project objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors. PQOs will be used as the basis for establishing the quality and quantity of data needed to support decisions.

Quality assurance. An integrated system of management activities involving planning, implementation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the client.

Quality assurance project plan (QAPP). A formal document describing in comprehensive detail the necessary quality assurance, quality control, and other technical activities that must be implemented to ensure that the results of the work performed will satisfy the stated performance criteria.

Quality control. The overall system of technical activities that measure the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality. The system of activities and checks used to ensure that measurement systems are maintained within prescribed limits, providing protection against "out of control" conditions and ensuring the results are of acceptable quality.

Quality system. A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out the required QA and QC.

Readiness review. A systematic, documented review of the readiness for the startup or continued use of a facility, process, or activity. Readiness reviews are typically conducted before proceeding beyond project milestones and prior to initiation of a major phase of work. A meeting with the project team that is held to review project expectations and to verify that all parties know their responsibilities and are prepared with the necessary equipment.

Reagent blank (RB). An aliquot of water free of measurable contaminants or solvent analyzed with the analytical batch and containing all the reagents in the same volume as used in the processing of the samples. The method blank goes through preparatory steps; the reagent blank does not.

Representativeness. A measure of the degree to which data accurately and precisely represent a characteristic of a population, a parameter variation at a sampling point, a process condition, or an environmental condition.

Requirement. A formal statement of a need and the expected manner in which it is to be met. Documented statements that specify activities that must be done. Mandated activities. Requirements contained within an approved EPA Regional Policy document, Standard Operating Procedure, Quality Management Plan, Federal Register, or other document.

Sampling and analysis validation. Confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled. Data validation is a sampling and analytical process evaluation that includes evaluating method, procedural, or contractual compliance, and extends to criteria based upon the quality objectives developed in the project QAPP. The purpose of data validation is to assess the performance associated with the sampling and analysis to determine the quality of specified data. [Compliance with method, procedural, and contractual requirements. Comparison to project quality criteria from the QAPP.]

Sampling and analysis verification. Confirmation by examination and provision of objective evidence that the specified requirements (sampling and analytical) have been completed. [Completeness check.]

Screening data. Analytical data of known quality, concentration, and level of uncertainty. The levels of quality and uncertainty of the analytical data are consistent with the requirements for the decision to be made. Screening data are of sufficient quality to support an intermediate or preliminary decision but must eventually be supported by definitive data before a project is complete.

Secondary data. Pre-existing or acquired information. May include aerial photographs or data generated for or by external, independent parties, which are then transmitted to the current user. Secondary data are commonly used during the preliminary assessment stage of the CERCLA process.

Sensitivity. The capability of a test method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest. Examples of QC measures for determining the sensitivity include laboratory-fortified blanks, a method detection limit study, and initial calibration low standards at the quantitation limit.

Shipping container temperature blank. A container of water designed to evaluate whether or not samples were adequately cooled during sample shipment.

Split sample. Two or more representative portions taken from one sample in the field or laboratory, analyzed by at least two different laboratories. Prior to splitting, a sample is mixed (except volatiles) to minimize sample heterogeneity. These are quality control samples used to assess precision, variability, and data comparability between different laboratories. (Should be used when accompanied by a PT sample.)

Stakeholders. Individuals or groups of individuals with a strong interest in the Agency's work and policies. This includes "affected parties" (individuals or groups directly affected by EPA policies or decisions).

Standard Operating Procedures (SOPs). A written document that details the method for an operation, analysis, or action with thoroughly prescribed techniques and steps and that is officially approved as the method for performing certain routine or repetitive tasks.

Storage blank (SB). Sample composed of water free of measurable contaminants that is stored with a sample set in the same kind of sample container beginning upon receipt of sample shipment at the laboratory. Analyzed at the end of the sample storage period to assess cross-contamination occurring during sample storage. Typically analyzed only for volatile organic compounds.

Surrogate spike (SS). A pure substance with properties that mimic the analyte of interest (organics only). Surrogates are brominated, fluorinated, or isotopically labeled compounds unlikely to be found in environmental samples and added to samples to evaluate analytical efficiency by measuring recovery.

Systematic planning process (SPP). A planning approach for environmental data operations that is based upon two primary elements: (1) the scientific method and (2) a commonsense, graded approach to ensure that the level of detail in planning is commensurate with the importance and intended use of the work and the available resources.

Usability assessment. See Data usability assessment.

Validation. See Sampling and analysis validation.

Verification. See Sampling and analysis verification.

Volatile organic compound (VOA) trip blank. A clean sample of water free of measurable contaminants that is taken to the sampling site and transported to the laboratory for analysis without having been exposed to sampling procedures. Analyzed to assess the contamination introduced during sample shipment. Typically analyzed only for volatile organic compounds.

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